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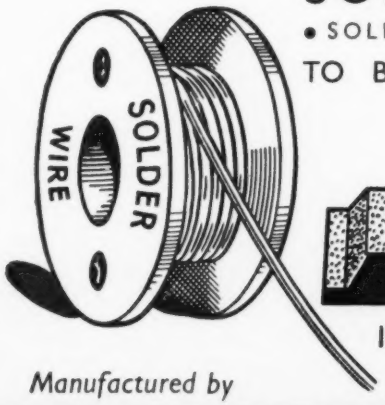

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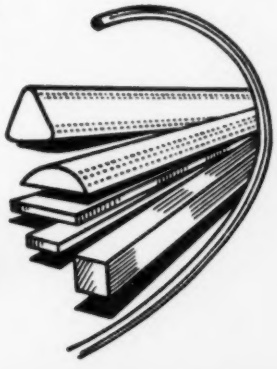

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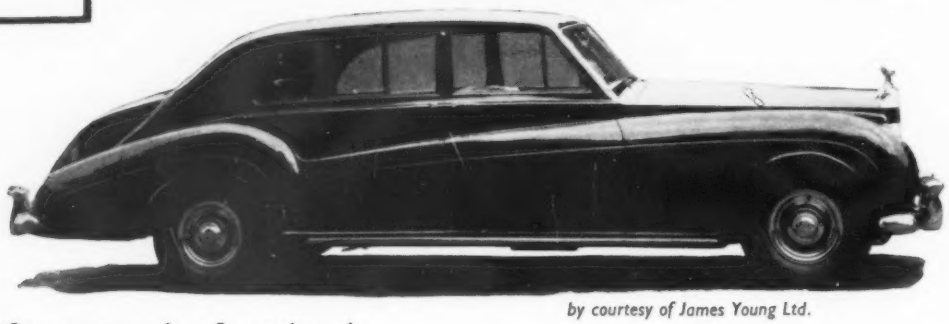

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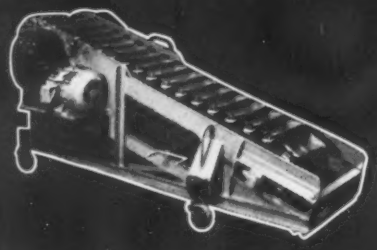

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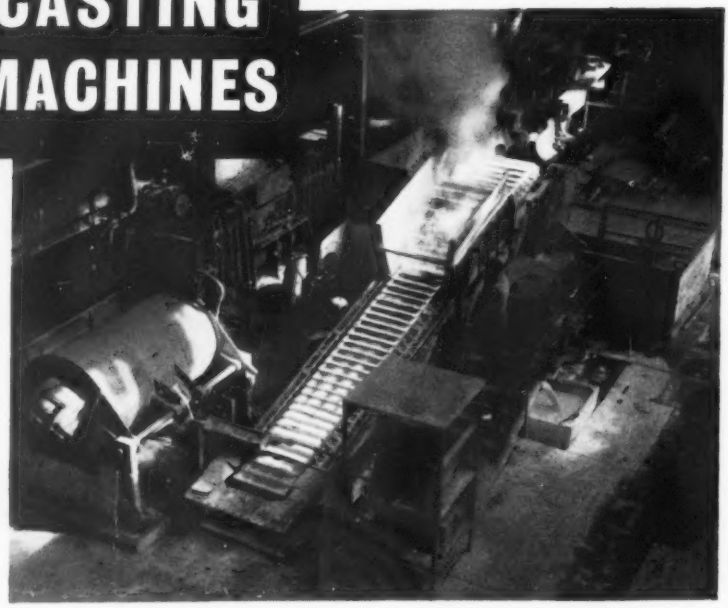

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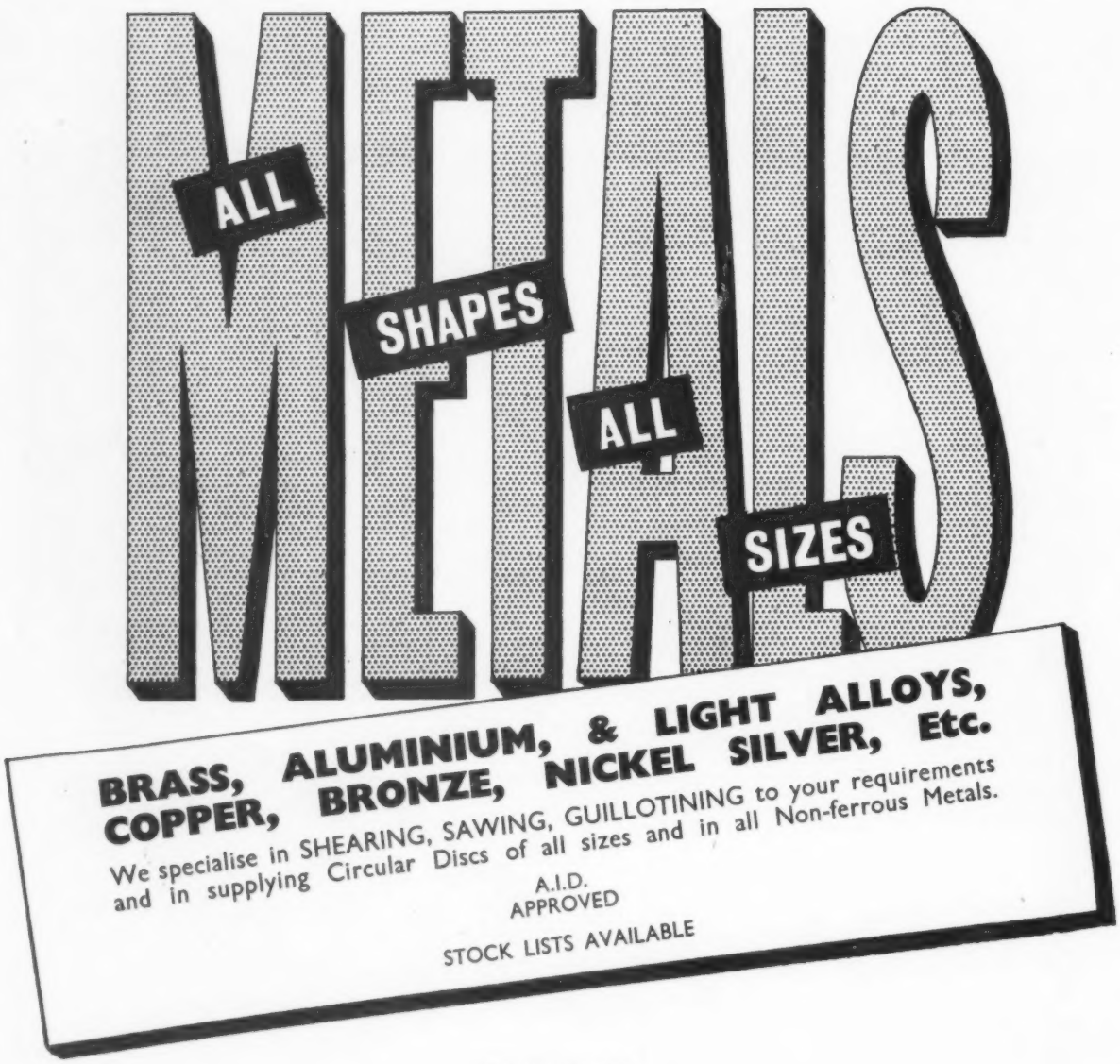

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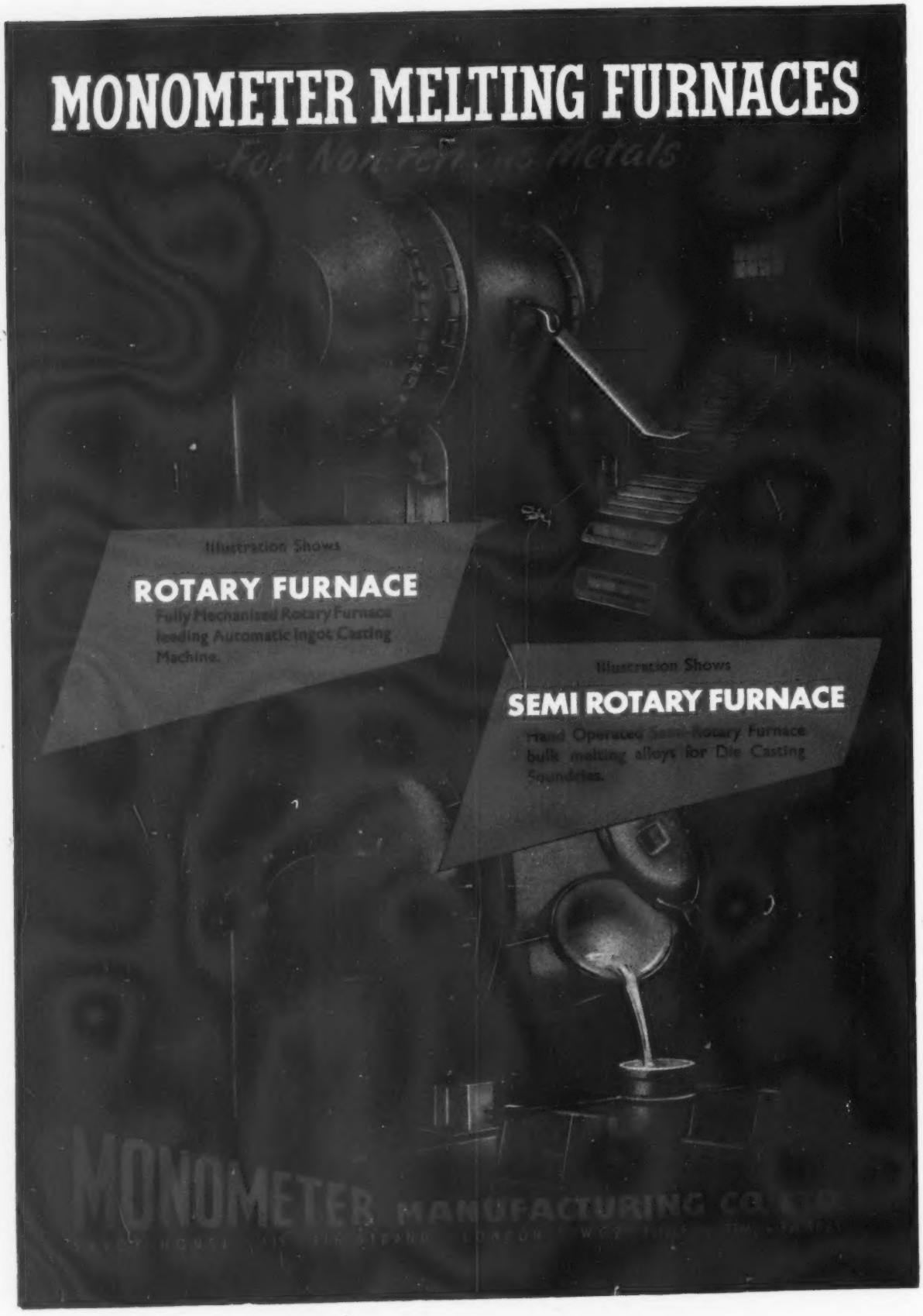
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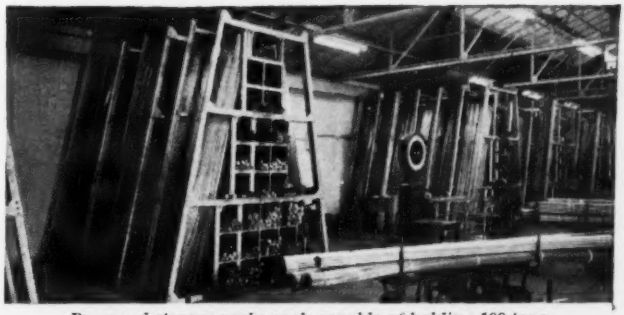

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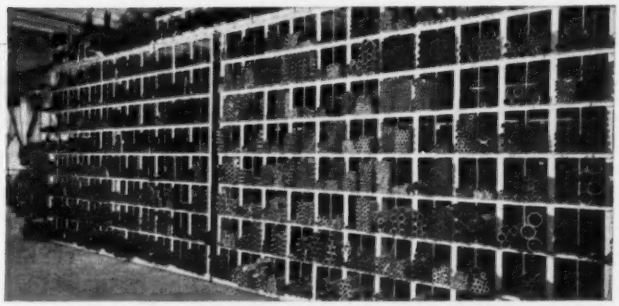

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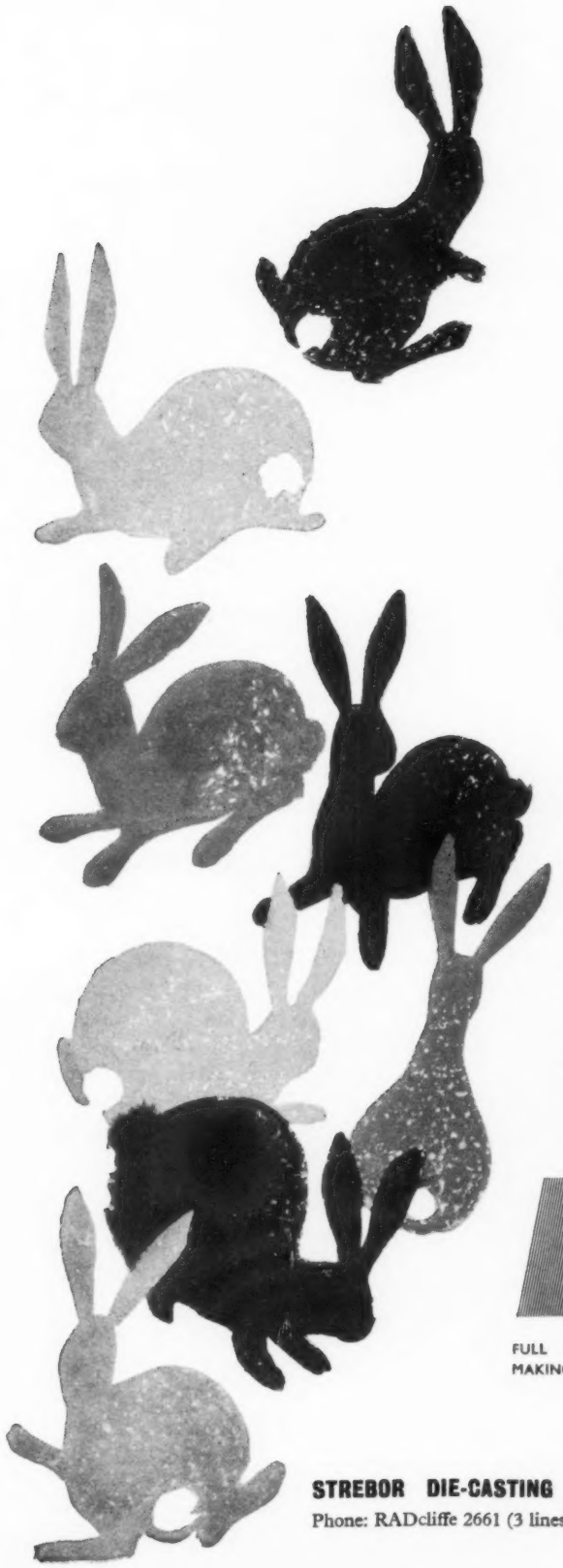

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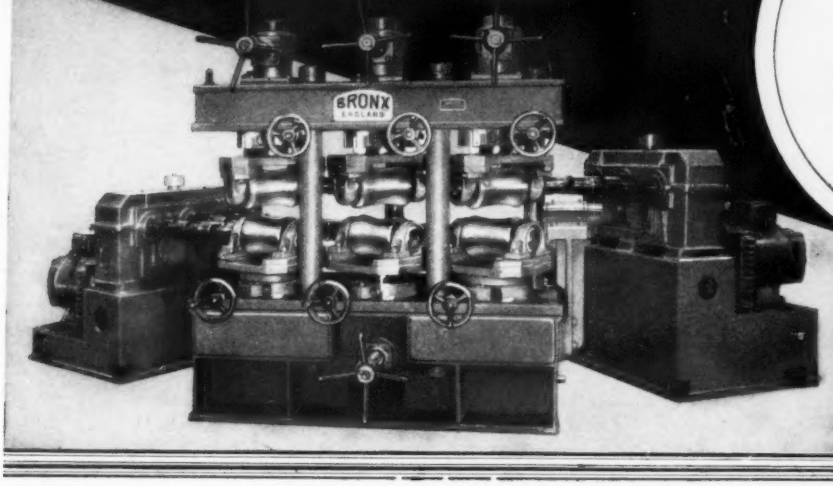

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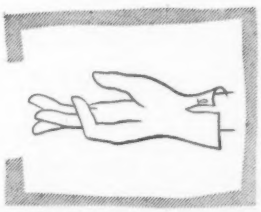

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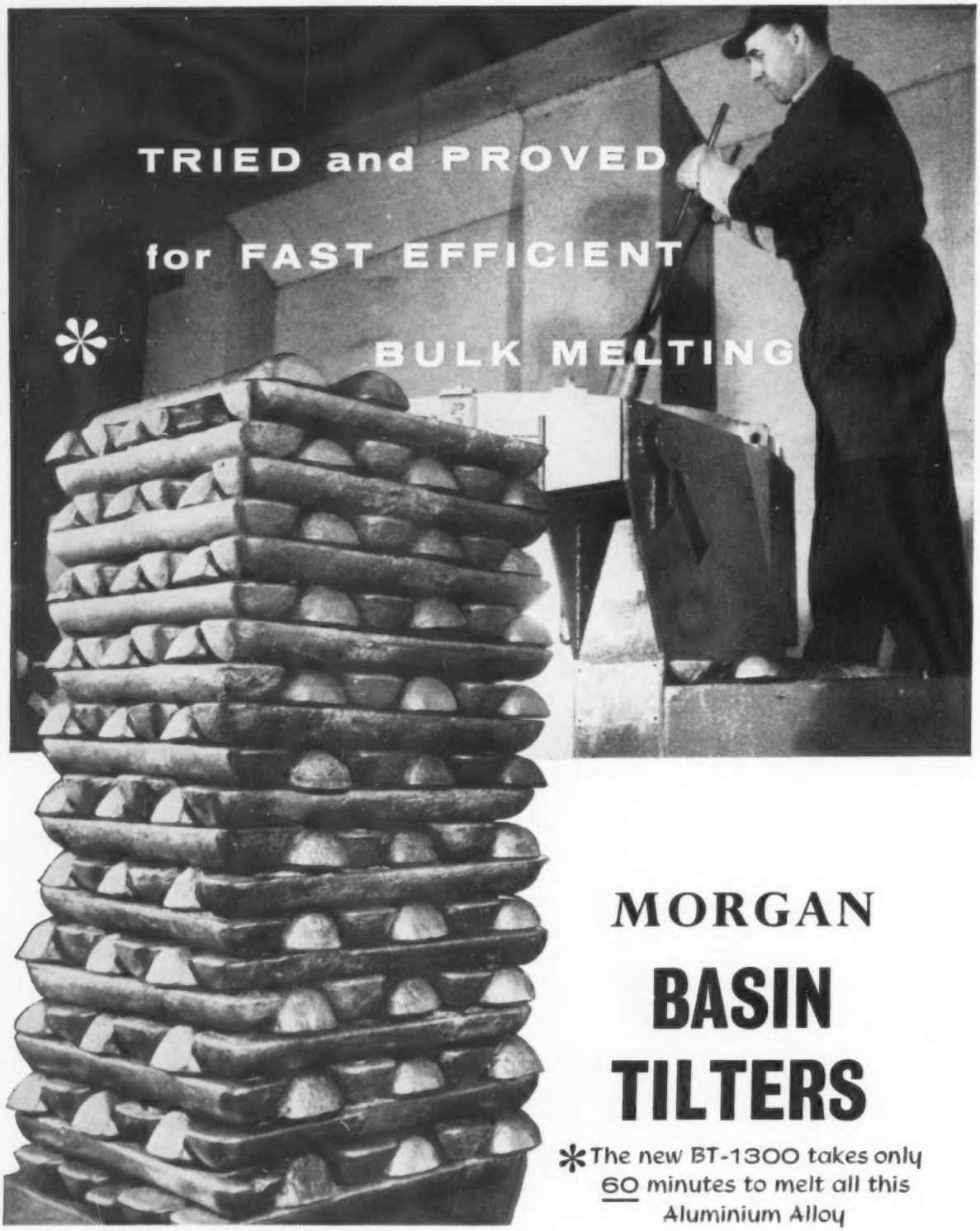

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16 JUNE 1961 VOLUME 98 NUMBER 24

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Electricity in Industry

A REAPPRAISAL of the power plant installation programme for England and Wales, in the light of the unexpected upsurge in demand for electricity, was suggested by Mr. Stanley F. Steward, director of the British Electrical and Allied Manufacturers' Association, speaking at the British Electrical Power Convention, held at Eastbourne this week. Nothing could be more damaging to the cause of electrical development than any uncertainty about the continuity of supply, said Mr. Steward. Bearing in mind the amount of old plant in service, the manufacturing capacity available and the likely trend of demand, it would seem to be shortsighted to run any risk of underproviding for generating plant requirements in this country during the next decade. When regard was paid to the pressure on industry to increase productivity, the growing adoption of automation, the clean air legislation, and the necessity to eliminate domestic labour, it was difficult, he continued, to resist the view that the rate of growth of demand for electrical power would be greater in the next decade than in the last. It is certainly apparent that the pace of this country's industrial growth must increase if it is not to fall behind its overseas competitors. This would inevitably add further to the demand for electric power.

Another speaker at the Convention said that the largest single contribution that could be made to improving the national electricity load factor would be the extension to a large section of industry of two- or three-shift working. The industrialist, said the speaker, already has a major incentive to that change in the spreading of capital charges and facilities over a larger volume of production, an incentive far greater than would be the offer of electricity free of charge outside the hours of the normal working day. The increasing investment in mechanization and automation will, however, bring pressure upon industrialists to adopt at least two-shift operation in their own economic interest and to the ultimate improvement of the utilization of electricity distribution assets. Dealing with new and improved applications of electricity and electrical equipment, the same speaker said that electricity for process heating was making rapid headway in most industries because it offered extreme ease and accuracy of control, improvement in working environment and increased output per man, as well as economies through the saving of storage space, reduction of rejects and avoidance of double handling. Induction heating and dielectric heating were contributing to the development of automation by the simplicity with which these heating methods could be fitted into a production line as an integral part of the process. Induction heating is now used for the melting of some 90 per cent of the high grade brass made in this country, continued the speaker, and individual induction heaters in a large press-forge shop having a rating of 800 kW at 3,000 cycles/sec. were capable of heating billets at a production rate of 2 tons/hr.

Looking into the future, Sir John Pickles said that the picture was one of all-round expansion of the use of electricity. Expansion of use in general industry continued unabated in process work, in motive power, and in automation and control. Regarding British prospects in the period 1970-1980, Sir John said that towards the end of that period it seemed likely that the greater part of the new generating plant would be nuclear but, due to its low capital cost, conventional thermal plant might be justified, especially for replacements in existing buildings.

Out of the MELTING POT

Flow Modifiers

IT has recently been discovered that, by cold rolling harder metals or alloys with a softer metal or softer alloy, the harder metal can be reduced in thickness by a smaller rolling load per pass than that which is required to produce a corresponding reduction in thickness when the harder metal is cold rolled alone. Alternatively, for a given rolling load, a sheet of harder metal can be reduced in thickness by a greater amount when rolled with a softer metal than would be possible if the harder metal were rolled alone. This discovery immediately reminds one of the recently reported observation of the profound change in the deformation mechanism in the case of sheathed extrusion billets after the thickness of the sheath has reached a certain critical value (this page, METAL INDUSTRY, 26 May 1961, p. 410). In the case of rolling, a sheet or strip of the harder metal can be rolled with a sheet or strip of the softer metal, or a sheet or strip of the harder metal can be sandwiched between two sheets or strips of the softer metal. It is believed that the reduction in rolling load, or the greater effect of a given rolling load, is due to the frictional forces arising at the interface of the dissimilar metals during the cold rolling operation, these forces modifying the stress distribution in the harder metal, as compared with the stress distribution obtained when rolling the harder metal alone. Load economy, therefore, depends upon the contact between the harder and softer metal surfaces and upon the initial hardness ratio of the two metals. It is obtained whether or not a lubricant is used, but may, however, not be as great when a lubricant is employed since some of the lubricant may seep between the surfaces of the sheets or strips, thereby facilitating relief of the internal tensile stresses imposed in the harder metal by the inter-surface friction. There exist optimum conditions, so far as the thickness of the softer metal is concerned, for maximum load reduction and these depend on the initial thickness of the harder metal. A limit also exists in regard to the total reduction of the metals, this limit depending on the metals being rolled.

Crude Mechanism

WHILE on the practical macroscopic scale the spark machining process can be most valuable, investigations by methods capable of yielding an insight into the mechanism of the spark erosion process cannot fail to leave one impressed by the utter crudity—on a microscopic scale—of the mechanisms that go to make up the phenomenon of spark erosion. One such recent investigation was concerned with the study of the dislocations developed in and around individual spark craters on the surface of single crystals of bismuth, antimony and zinc. The surface was first etched to observe the original dislocation density in the material. It was then subjected to a single spark discharge (with the surface acting as anode or cathode) and then re-etched to examine the dislocations around the spark crater. Progressive dissolution of the surface was used to study the distribution of dislocations below the surface and below the spark crater. The observations of the density and distribution of dislocations accord satisfactorily with the mechanisms thought to be responsible for their formation. These include the shock wave which arises in the inter-electrode space during the discharge, the melting and subsequent quenching of a small volume of metal, and the development of thermal shock stresses around the crater. There are significant differences between anodic and cathodic craters. Melting appears to occur only in the anodic craters, with the result that the consequent thermal shock stresses around the crater are of relatively long duration and give rise to dislocations over a relatively wide area. When the surface is cathodic, the thermal stresses develop so rapidly that they result in the spalling-off of particles of metal, while the time available for the generation of dislocations is very short, the number of dislocations produced being correspondingly limited. Investigations of this nature may be expected, in due course, to provide information that could be used as a basis for the control of the electrical parameters of the spark discharge with a view to enhancing particular mechanisms of the spark erosion process.

Controlled Pretreatment

PICKLING of readily oxidizable metals such as aluminium, magnesium and titanium, for the purpose of removing the surface oxide film in order to ensure satisfactory adhesion of subsequent electro-deposits or other coatings, must always of necessity be somewhat haphazardly hopeful. Even if the oxide film is removed at some stage of the treatment, another film will inevitably form during subsequent rinsing and transfer operations. If these are sufficiently closely controlled, all that can be hoped for is that the oxide film formed and its effects on the adhesion of the subsequently applied coatings will be reasonably consistent. A more realistic procedure, as, for example, in the well-known zincate process, combines the removal of the surface oxide film with the subsequent formation under controlled conditions of another surface film which may, with greater certainty, be expected to have more closely reproducible characteristics and a more consistent effect on the adhesion of subsequently deposited coatings. A further step towards closer control of the inevitable surface film can be achieved by electrolytic treatment of the surface. Uncontrolled and uncontrollable variables can sometimes be largely eliminated by carrying out such a preliminary treatment in the actual plating bath, e.g. by anodic treatment of the work immediately prior to plating. While this principle has been known in connection with the electroplating of aluminium, in particular chromium plating, a procedure based on it has now been suggested for preparing aluminium and aluminium alloys for chemical nickel plating by the hypophosphite process. Using D.C. for the preliminary treatment, the aluminium is connected to the positive pole of the supply for 30-60 sec. in a chemical nickel plating bath having a *p*H of 4·7. The electrolytic treatment results in the formation of an oxide film having a thickness of about one micron. The current is then switched off and the work is left in the bath for, say, one hour. The nickel deposit formed on the work will be much more adherent than similar deposits formed on aluminium pretreated by conventional processes.

Skimmer

DETAILED EXAMINATION OF PROBLEMS ENCOUNTERED IN GEARBOX EXTENSION DIE

Facets of Pressure Die Design

By W. GOODE

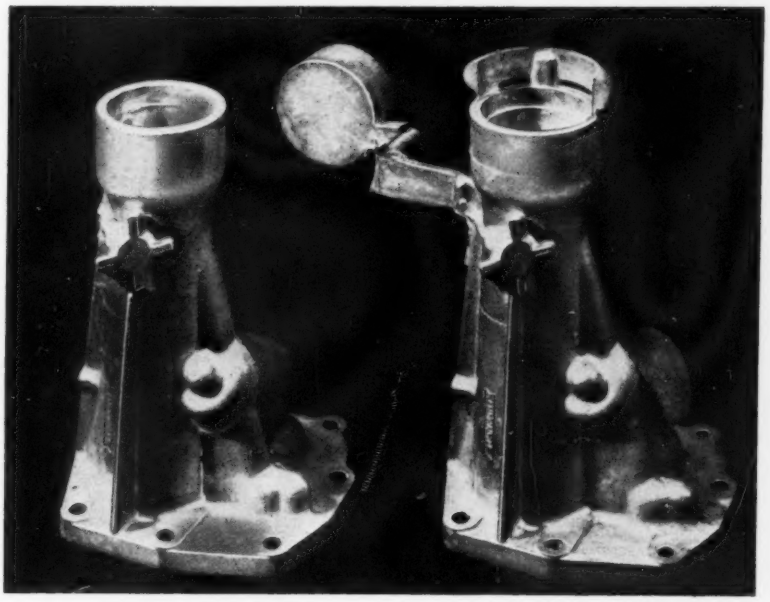
(*Die Designer, Birmingham Aluminium Casting* (1903) *Co. Ltd.*)

A PROBLEM frequently faced by the designer of tools for high pressure die-casting is that parts moving within the die proper become, in the process of design, relatively large. They then assume such proportions that the total load imposed on them by the injection of molten metal is almost equal to that sustained by the rest of the die cavity, which is to say that the relative projected areas of impingement of molten metal are nearly equal. All in all, then, if the smallest die-casting machine consistent with satisfactory die closure is used, then an additional machine of like rating seems indicated to effect complete homing of the slides. Reference to Fig. 1 should clarify the point. Small wonder that the designer is constantly posing the query—should the slides be treated as the die proper and vice versa?

With the advent, in the last decade, of the gearbox extension which the motor industry, well aware of the advantages of pressure die-casting in aluminium, demanded as a pressure die-casting, a radically new approach had to be made to this problem. Here now were all the ingredients for the design, completely unprejudiced by current practice, of a die devoid of the high cost (and other undesirable features to be enlarged upon later) clearly unavoidable if a conventional approach were made. Reference to Fig. 2 will show clearly that the hitherto ancillary die members (slides) will require a force to lock them in position greater than the economical locking load of the machine upon which the die is mounted. Also, it is apparent that the points at which molten metal can be introduced are severely restricted, unless recourse is made to passing the stream of metal across the faces of the slides. The latter is a practice to be avoided if few "flash" problems, dimensional stability of component, low remelt and avoidance of undercuts are to be obtained.

Not only is the tremendous size of these moving parts objectionable, but the bulk of metal in the main die block to house these parts is conservatively twice the bulk of the slides. In addition, the motivating power for these parts, usually a hydraulic cylinder, is very bulky, as also are the locks and lock anchorages. In attachment of the cylinder and the provision of a lock, design is considerably hampered by trailing water lines needed for cooling these members, presenting as they do a problem in themselves by virtue of their characteristic to-and-fro movement.

Merely to machine the cavities, hitherto formed in the slides, into the main die blocks which were directly coupled to the platens of the machine, was by no means the simple answer one might be led to believe. Indeed, as designers at the author's works well knew, fresh problems would inevitably arise. Outstanding among the latter, as will be seen by reference to Fig. 3, was the problem presented by the fact that the die part, now ancillary, which was to form the major part of the inside shape of this car gearbox component, was, in itself, of a most irregular shape, and was to be surrounded by a cluster of small round cores needed to provide fixing holes in the flange.



Trimmed and untrimmed pressure die-cast gearbox extensions in aluminium alloy

Fig. 1—Die design often necessitates slides being larger than is normally desirable

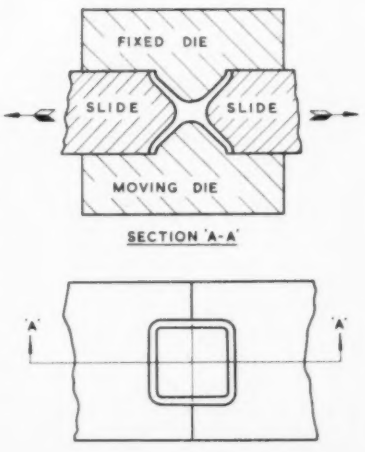
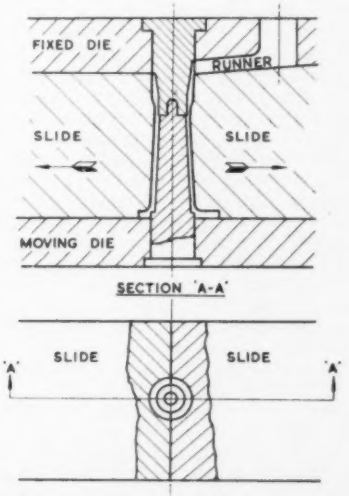
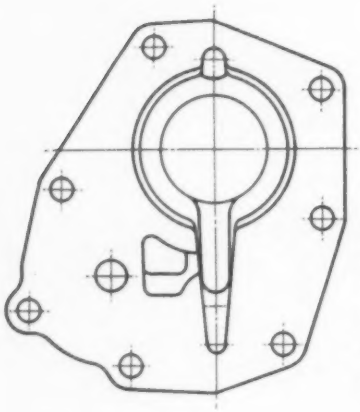


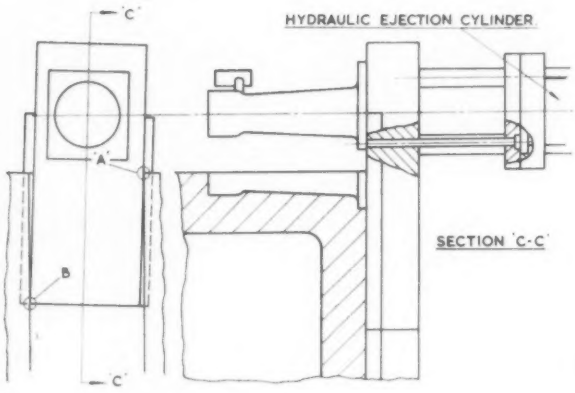
Fig. 2—In this arrangement the slides are massive in relation to the die blocks

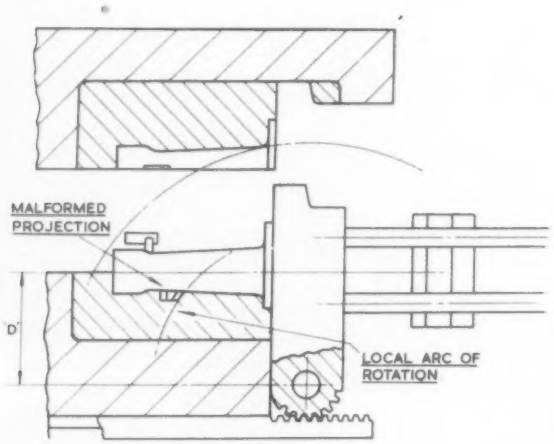




Left: Fig. 3—View on bolting face of automobile gearbox extension showing complexity of coring

Right: Fig. 4—Diagram showing dead weight of "tee" structure being taken at points "A" and "B"





Left: Fig. 5—Diagram showing one stage in the development of the hinged structure using a rack to provide rotation

That this should pose such a difficult problem is due in the main to the close proximity of these small cores to the parent core and the consequent restriction imposed on design, which will now be investigated in greater detail.

The simple answer, of course, would be to form the whole of the flange face on a stepped-up parent core, with the small cores inserted, the whole then being withdrawn from the cavity across the die face parallel to the parting line. In adopting this method the designer would be forced into calling for the machining of the irregular profile of the flange face—both male and female for a considerable distance bedding one to the other—a costly business which would inevitably lead to slow operation of the die, due to the flash getting into these joints which, in turn, would lead to high dressing costs. Not to bed this profile as described could only mean a further increase in the size of this moving member to encompass completely the flange face, so allowing flat bedding faces to be introduced. However, flash would now occur at 90° to that hitherto and would inevitably lead to undue stresses on die parts, since undetected particles of flash would tend to adhere to those faces of the die and core brought together when the core is sent home, with a result, in effect, of lengthening the core. The consequential dimensional instability here would not be serious, but the heavy flash which would block the ends of all through holes certainly would.

In addition to what has already been said regarding withdrawing across the die face, provision for stripping of the casting from the core would necessitate modification of the component, and consequently would involve concessions from the customer. In view of the other objections, an approach to this end was not made.

The core would have to be made as outlined above with the exception that the casting must be pushed off the core via ejectors, rather than the core being

View of flange face of gearbox extension die-castings showing multiple coring

pulled out of the casting. Clearly, with the die in its new form this could only be possible subsequent to preliminary ejection of the casting with the core *in situ*, clear of the die face and on a sufficiently rigid superstructure to support the whole of this secondary ejection mechanism.

So far, so good, but reciprocating parts are most difficult to lubricate in their guides in the best of circumstances, but in die-casting there is the ever-present hazard resulting from the deposition of abrasive foreign matter, coupled with the effect of heat to be considered. Furthermore, the whole weight of this tee-shaped mass, as will be seen by reference to Fig. 4, would be concentrated on two narrow edges only. Taking into account also the ample working clearance which would have to be put into the guides for reasons stated above, the impact of molten metal upon the face of the structure would push the mass to one side, leaving a gap in what is actually part of the impression itself, so forming a most definite avenue for the formation of heavy flash with the overriding menace to the safety of the machine operator.

The gap referred to above and the desirability of locating the parent core at both ends, suggested that, rotated about a certain centre, this tee structure, by the very action of locating the extreme tip, could be made to close this gap and, indeed, help to lock the faces together. This act of location would take the usual form adopted with castings having through holes and requiring long, slender cores; namely, that of piloting a core introduced from one end of the casting, into a core from the opposite end. A core from both ends is usually necessary, as indeed it is in the case under consideration, due to the presence of undercuts. This piloting of cores normally serves a double purpose in that, in addition to ensuring the concentricity of the internal shape at one end of the casting with that at the other, it also guards against the wall thickness of that part of the casting surrounding the long core being above that required in one sector, and a corresponding amount undersize in a sector diametrically opposite. Such a situation could restrict the flow of metal to a degree where the production of sound castings was impossible—to any lesser degree, the dimensional instability would in all probability lead to rejection of the castings.

It would seem, therefore, that this was the most promising line of development since patently the embedding of one core in the other would assist in three ways.

It soon became abundantly clear that support for the tee-structure was now vested only in the physical size of the hinge pin to be used as the centre of rotation, provided all other necessary requirements were met (see Fig. 5). Further, efficient lubrication of the hinge pin was possible and it could be sealed against foreign matter. An unsought though considerable benefit would accrue if this approach were successful, in that the component would be removed hydro-mechanically from between the machine platens so eliminating the necessity for any part of the operator's person to come between the platens to remove the casting. Never before or since, to the writer's knowledge, has this been achieved with such precision and complete absence of the slightest chance of distortion of the product. In addition, this extractor, in reality the ejector block, could in this position be kept scrupulously clean with supreme ease. The ejectors could also be readily lubricated, since the whole was virtually placed into the hands of the operator, albeit weightless.

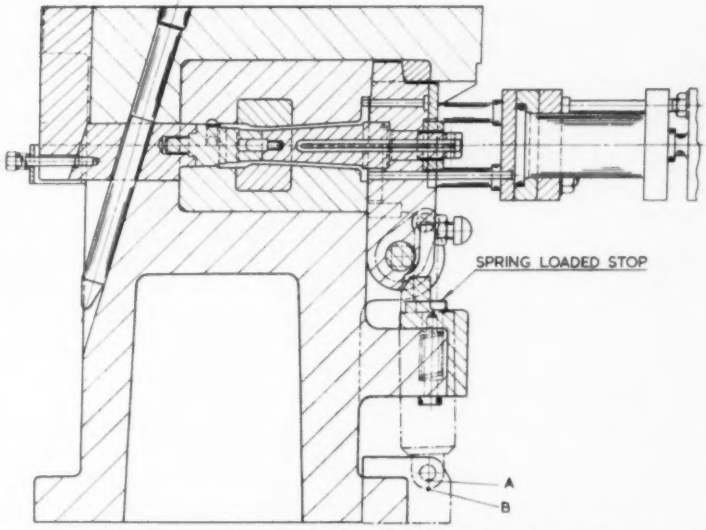


Fig. 6 (a)—Cross-section of die (closed position). Transference of thrust from point 'A' to point 'B' would eliminate wear on hinge pin (see text)

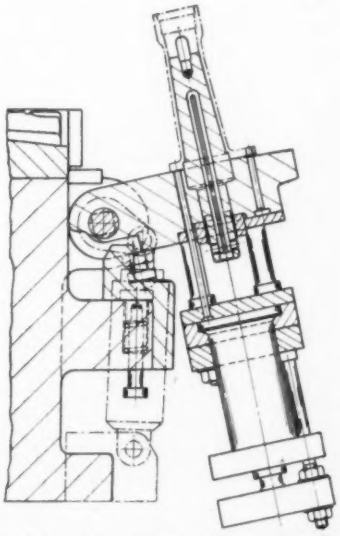


Fig. 6 (b)—Cross-section of die, open position

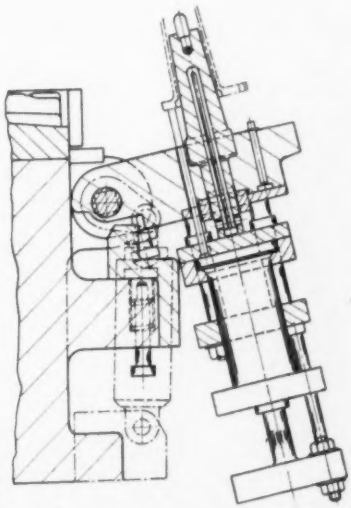
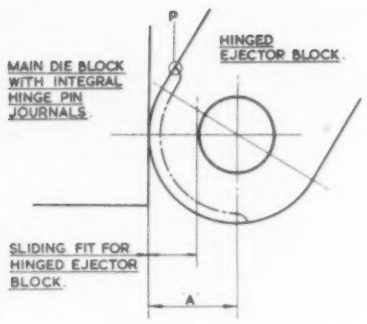
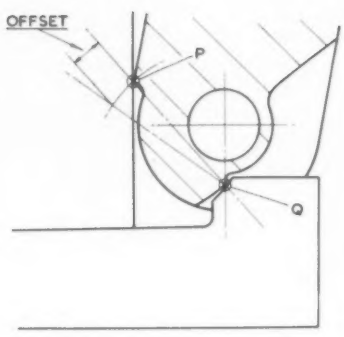
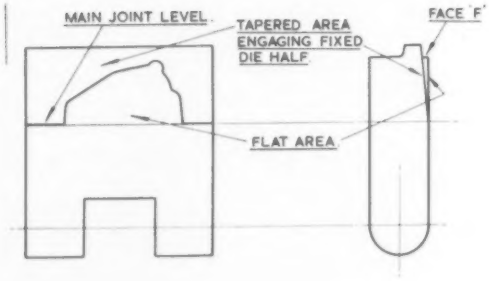


Fig. 6 (c)—Cross-section of die, open position with casting ejected

A prime consideration, of course, in rotating this assembly was that its extreme arc should clear the stationary die member, together with its protuberances, dowels, locks, etc. This condition, in the final analysis, was determined by the extent of the opening of the machine platens. As can be seen by reference to Fig. 5, the greater the distance "D" the better chance of clearing there would be, and indeed the greater the seal, which could in no circumstances be greater than distance "D" because if it were, the assembly would be prevented from rotating. The magnitude of distance "D" was limited, however, by the extent to which malformation of certain projections on the component was possible in order to avoid undercuts to the local arc of rotation. A satisfactory com-







Above: Fig. 7—Diagrammatic arrangement showing hinge block relieved to obviate need for sliding fit

Above Right: Fig. 8—Arrangement of "reaction wedge lock"

Left: Fig. 9—Preliminary machining of hinged block

promise was reached notwithstanding the fact that ultimately, as will be shown later, the seal was to be reduced to a distance considerably less than "D".

A start was made by putting a core jack-operated rack centrally at the back of the moving die block, to engage with radial teeth cut on the back end of the hinged block, also as seen in Fig. 5. However, because of the shock loading in the form of a pure shear stress on one particular tooth at the initiation of the return of the tee assembly, this idea was discarded in favour of link operation via a hydraulic cylinder with rear trunnion mounting. A diagram showing this general arrangement is shown in Fig. 6.

This decision was influenced in no small measure by the necessity for providing a "reaction wedge lock", the best position for which was centrally to act upon the hinged block at a point currently occupied by the gear teeth. The necessity for this "reaction wedge lock" and the form which it took, will now be enlarged upon.

A fundamental factor in further design at this juncture, was that preservation of the running fit between the hinge pin and its journals was being threatened by the objective of a final wedge locking action at the closing of the hinged block. Also threatened was the minimum of a sliding fit, necessary to sections of the hinged block passing between the inner edge of the pin and the main die block, see Fig. 7.

A reduction in centre distance "A" and the relieving of the hinged block as shown chain dotted, would dispose immediately of the question of sliding fit, because the instant that point "P" on the hinge block contacted the journal block, rotation of the hinge would cease about the pin and commence about point "P".

Rotation about point "P" would immediately begin to reduce the running fit on the hinge pin; in fact, the reaction from the load imposed by the operating cylinders, probably with an increased mechanical advantage, would all be taken on the hinge pin. To increase the size of the hinge pin would not eliminate wear on that member since, as designers well know, however small the clearance in a journal, if it exists, heavy alternating loads, alternating in direction that is, give rise to very rapid wear. Therefore, the reaction must be absorbed by other means, and, depending on distance "A", provide the necessary interference fit desired at closure. The position of point "P" determines the angle of the hinge block at the initiation of the wedging action and, incidentally, the reducing factor referred to earlier affecting the amount of seal in this area.

As amply demonstrated above, the absorption must start the instant that point "P" contacts the journal block; accordingly, an arc was struck of convenient radius from this contact point as being one of two elements required to locate a simultaneous contact point on a "reaction wedge lock". The other component selected was the centre line of the hinge pin produced parallel to the sealing face. Thus was pin-pointed the commencement of the wedge action, point "Q", Fig. 8. A look at this point "Q" will show that it lies on the hinge boss; therefore, metal forward of this point in the direction of rotation must be removed to permit correct disposition of the "reaction wedge lock". This lock would be attached to the journal block in such a manner that it could be regarded for all intents and purposes as being integral. Its contact face would be in the form of an arc equal in magnitude to that creating the convex contact face on the heel of the hinge block. Its centre would, however, be slightly removed from that of the latter, lying as it does on an arc centred on the new contact point "Q" and with a radius equal to that of the curved faces, so providing the wedge action.

The offset, see Fig. 8, must be kept to a minimum consistent with efficient locking action in order to avoid excessive strain on the parts involved. Still with the object of keeping a running fit allowance as the minimum requirement for the hinge pin now that the total locking load was otherwise absorbed, it was thought necessary to make absolutely certain that none of the load could ever be sustained by the pin by slightly increasing the allowance; a step attended with success.

Looking back for a moment to the position taken up by the hinge block at the instant point "P" contacts the face of the moving die half proper, it was hoped that an arrangement could be made for the block to be held in this position whilst closing the die, in which case the angle taken up by the core-side face on this block would provide a natural lead-in for the face on the fixed die half which was to mate this cavity sealing face.

Unfortunately, this had to be ruled out for two reasons. First, the power from the hydraulic cylinder could not be controlled with sufficient accuracy to guarantee that the hinge block would not go home prematurely. Secondly, on the dowel locating this radially homing core to its automatic counterpart, there would be imposed loads which could not be sustained having regard to the excessive reduction in strength which would take place when the appropriate amount of taper was put upon the dowel to make full engagement, in fact, possible. So the task of selecting other means of preventing fouling of the die parts had to be faced. Since this natural taper was no longer a factor to be utilized, provision of taper in excess meant the accurate bedding of that part of the profile of the die abutting the hinge block upon the hinge block, nevertheless confined to areas engaging the fixed die half.

As shown in Fig. 9, this operation supplied the boundary between those parts of the face which could be tapered and those which could not. Also evident here is the fact that this taper would have to be milled on the block, a laborious procedure better avoided. In this connection, since the flat area indicated formed the bolting face of this gearbox component and had to be machined, an effort was made to obtain a concession to supply this face tapered, so deriving the obvious benefit of bedding a pair of faces both of which could be "stroked" in machining. Understandably, this was not forthcoming, because of the excessive local

stock removal implied in the suggestion.

So the face had to be milled as stated, but it should be noted that the difficulties were considerably minimized by a decision not to bed the profile in depth (see face "F", Fig. 9) but to allow what is termed a "positive flash" of 0·005 in. to the profile.

In conclusion, all that remains is to attempt a forecast of modifications likely to be incorporated in further replacement tools if these are required.

First, it would seem to be a fairly simple matter to "short-circuit" the rather roundabout and troublesome method of transmitting torque to the hinge block from the hydraulic cylinder. At the moment, transmission is via a link secured to a square section of the hinge pin, secured in turn to the hinge block by a peripheral drive pin. If the link became integral with the hinged block, intermediaries would be eliminated.

Second, a rather formidable task, which, however, seems just possible, would be to utilize the inertia of the tee mass swinging from between the opened die, to eject automatically on completion the casting from the hinged ejector block, so dispensing with the use of a hydraulic cylinder for this purpose. This inertia is at present dissipated by a spring-loaded stop.

Third, the three hinge points in this set-up will be examined bearing in mind the benefits of the greatly increased bearing area to be obtained if the loads could be transferred from the pins to the outside of their journals (see cross-section of closed die, Fig. 6).

Finally, an examination of the possibility of providing a "reaction wedge lock" for the hinged ejector block, with its point of contact on a line through point "P", Fig. 8, parallel to the main die joint, is likely to meet with success and benefit.

Atomic Progress

Fission Fragment Damage in Ceramics

A LARGE amount of data has been accumulated on the in-pile behaviour of both fissionable and non-fissionable ceramic metals. Uranium dioxide is an obvious example of a fissionable ceramic with good radiation stability, and alumina is an example of a non-fissionable ceramic with good crystallographic stability to fast neutron irradiation.

Dispersions of UO_2 in alumina are attractive as fuel materials because the effective thermal conductivity is expected to be higher than that for UO_2 alone. Furthermore, the physical and chemical properties of alumina are attractive since it has a low neutron cross-section, high mechanical strength and high resistance to corrosion in hot-water environments. Fission gas may also be more effectively retained in fuel materials having ceramic coatings round individual fuel particles. Another attractive fuel material is a solid solution of UO_2 in ZrO_2, yielding a uniform fuel with rather lower neutron absorption cross-section than UO_2. In such applications as these, the ceramics are subjected to fission fragment bombardment as well as to neutron bombardment due to their close proximity to the fuel. A Paper by Berman, Bleiberg and Yeniscavich[1] describes work undertaken to provide data on the behaviour of this type of fuel material under reactor conditions.

Experimental Data

These workers investigated the behaviour of ceramic compounds, solid solutions and dispersions of insoluble and partially soluble compounds. The actual compositions, crystal symmetries and details of the phase structures are shown in Table I.

The fuel plates were clad either in Zircaloy 2 or aluminium and irradiated to between 1×10^{18} n.v.t. and $1{\cdot}6 \times 10^{21}$ n.v.t. at surface temperatures from 40°C. to 392°C.

Post-irradiation examination included density measurements, metallography and X-ray diffraction studies. Measurements showed that the $Al_2O_3 + 21\ UO_2$ fuels all exhibited about 18 per cent decrease in density which was independent of burn-up in the range examined. X-ray data supported the view that the density decrease was solely due to swelling of the UO_2. The microstructure of this fuel was markedly affected by irradiation. Grain boundaries and rounded voids in the Al_2O_3 disappeared and elongated voids and tails on the UO_2 were evident after irradiation.

The microstructure of the $ZrO_2 + 13$ wt. per cent $CaO + 17$ wt. per cent UO_2 showed a slight change in that the UO_2 particles developed a "halo" effect at the interface boundaries. This is attributed to fission fragment damage to the tetragonal zirconia phase, although it appeared to be much smaller than expected from the calculated range of fission fragments in this material. The UO_2 itself showed slight cracking.

X-ray diffraction profiles were obtained before and after irradiation using a double-crystal spectrometer. Before irradiation, as expected for the $Al_2O_3 + 21\ UO_2$ fuel, diffraction patterns of UO_2 and Al_2O_3 were superimposed. After irradiation, only the UO_2 pattern was detectable; though the peaks were slightly less intense and broader. The linear dimensions of the lattice cell had increased very slightly, by 1 part in 1,000. Berman *et al* conclude that irradiation has destroyed the crystal lattice of Al_2O_3.

Zircon ($ZrSiO_4$) is sometimes found in an amorphous state in nature. These zircons contain small amounts of uranium and/or thorium and the loss of crystal structure has been attributed to alpha particle bombardment. Berman and his co-workers irradiated plates of $ZrSiO_4 + 25\ UO_2$ and found a similar loss of crystal structures to that occurring with the $Al_2O_3 + 21\ UO_2$ fuel. Control samples of Al_2O_3 and $ZrSiO_4$ retained their crystalline structures after comparable or greater amounts of neutron bombardment.

Irradiation of U_3O_8 destroyed its crystalline structure and a few broad maxima occurred in the profile as was observed for the $ZrSiO_4 + 25\ UO_2$ fuel. This type of pattern is similar to those for liquids and glasses.

UO_2 shows only a slight increase in lattice dimensions during irradiation. In the cubic solid solution of UO_2 in ZrO_2 a similar lattice expansion was observed initially. However, instead of

TABLE I—CERAMIC COMPOUNDS STUDIED

Composition (wt. per cent)	Crystal Symmetry	Phase Details
Compounds		
UO_2	Cubic	Single phase
U_3O_8	Orthorhombic	" "
Al_2O_3	Hexagonal	" "
$Zr\ SiO_4$	Tetragonal	" "
Dispersions		
$Al_2O_3 + 21\ UO_2$	Cubic; Hexagonal	Two insoluble phases
$Al_2O_3 + 80\ UO_2$	Cubic; Hexagonal	" " "
$Zr\ SiO_4 + 25\ UO_2$	Cubic; Tetragonal	Two phases limited solubility
Solid Solutions		
$ZrO_2 + 80\ UO_2$	Cubic	Single phase
$Zr\ O_2 + 13CaO + 17\ UO_2$	Tetragonal; Cubic; Orthorhombic	Three phases, two of which are solid solutions

the unit cell remaining constant with further irradiation, as for UO_2, it decreased. The diffraction profile remained that of a single cubic phase.

Discussion

The destruction of the crystal structure of Al_2O_3 in $Al_2O_3 + UO_2$ fuels is associated with a volume increase of about 30 per cent. This swelling would be a serious difficulty if such dispersions were used as fuel since coolant passages would be restricted and there would be a risk of cladding failure. There is ample evidence of the stability of Al_2O_3 where subjected to neutron irradiation alone, and it must be concluded that the damage is due to fission fragments. The effects of fission fragment bombardment cannot be predicted from either neutron or alpha particle bombardment data. Furthermore, not all ceramic materials are rendered amorphous when bombarded in this way and UO_2, $ZrO_2 + UO_2$ and $ZrO_2 + CaO + UO_2$ all exhibit good stability in pile.

Berman, Bleiberg and Yeniscavich have calculated the number of displaced atoms caused by fission fragments in $Al_2O_3 + UO_2$. While the Al_2O_3 is almost entirely within the range of fission fragments, the calculated number of displacements seems too low to account for the disappearance of the structure (of the order of 1 atom in 130 is affected).

It seems unlikely that displacement spikes are responsible for the damage because the energy level of the fission fragments would have to be extremely low before the threshold value is reached.

In Al_2O_3, most of the energy is dissipated in ionization and this portion of the energy may account for some displacements in ionic crystals. However, it cannot contribute to the displacements in $ZrSiO_4$, which is largely covalent.

Conclusions

Berman and his colleagues finally considered the possibility that the fission fragments act indirectly, through anisotropic effects, which distort the lattice and render it unstable. The first requirement is that the substance must be anisotropic if it is to be damaged. All the materials showing fission fragment induced phase changes were anisotropic. The CaF_2 type cubic materials did not show these changes. The presence of high temperature or metastable allotropic forms might also indicate that the structure is comparatively unstable. Al_2O_3 has a metastable gamma form and U_3O_8 has a high temperature form. The existence of more than one stable configuration between an ion and its nearest neighbours may be an indication of instability. In Al_2O_3 the aluminium ion is surrounded by six oxygen atoms; but in many silicates it is surrounded by four atoms. A further point may be the stability of the amorphous phase when formed. The principal result of this work has been to demonstrate that a wide range exists of materials that are unsuitable for use within the range of fission fragment recoil because their structure is destroyed, with consequent deterioration of their physical properties. At present it is not possible to predict the likely effects on given fuel materials and it will continue to be necessary to test exhaustively each potential fuel under closely-simulated operating conditions.

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[1] R. M. Berman, M. L. Bleiberg and W. Yeniscavich; *J. Nuclear Materials*, 1960, **2**, (2), 129.

MEN and Metals

In the list of Birthday Honours, the following awards were announced:—

Knights Bachelor — Mr. W. K. G. Allen, chairman and managing director of W. H. Allen Sons and Company Limited; **Mr. Sydney Barratt,** chairman, Albright and Wilson Limited; and **Mr. A. G. B. Owen,** chairman and joint managing director of Rubery Owen and Company Ltd.

G.B.E.—Sir Ivan A. R. Stedeford, chairman and managing director, Tube Investments Limited.

C.B.E. — Mr. A. F. Lampitt, managing director, Telephone Cables Limited; **Dr. L. F. C. Northcott;** principal superintendent, Materials and Explosives Division, Armament Research and Development Establishment, War Office; **Mr. G. A. Whipple,** chairman and managing director, Hilger and Watts Limited.

Appointments to the board of W. Canning and Company Limited, additional to those announced in this journal two weeks ago, are the following: **Mr. E. L. Masek** to be director responsible for London, Sheffield and Glasgow branches, and **Mr. B. Tromans,** F.R.I.C., to be director responsible for the manufacture and control of chemicals, abrasives and polishing materials, and for the technical centre and research laboratories.

Secretary of Frederick Smith and Company (Wire Manufacturers) Ltd., **Mr. Francis Maurice W. Hird,** F.C.A., F.C.W.A., has been elected President of the Institute of Cost and Works Accountants.

On August 1 next, **Mr. R. G. Huxtable,** M.B.E., will be the new secretary of The Gas Council in succession to **Mr. Wilfrid Bailey,** who becomes deputy chairman of the Southern Gas Board.

At the annual general meeting of the Institution of Mining and Metallurgy, held in London yesterday evening, **Mr. A. R. O. Williams,** O.B.E., A.R.S.M., B.Sc., was inducted as President for the session 1961-62. During the meeting, the following awards of the Institution were announced: The Gold Medal for 1960 to the **Rt. Hon. Lord Baillieu,** K.B.E., C.M.G., M.A.; the Consolidated Gold Fields of South Africa Limited Gold Medal to **Mr. Robert Nelson Pryor,** A.R.S.M., B.Sc., M.I.M.M.; the Consolidated Gold Fields of South Africa Limited premium of forty guineas to **Mr. Martin Lawrence Fitzgerald,** A.W.A.S.M., M.I.M.M.; the "Arthur Claudet" Student's Prize to **Mr. Peter David Ralph Maltby,** A.R.S.M., B.Sc., A.M.I.M.M.; and the "William Frecheville" Student's Prize to **Mr. Arthur George Darnley,** B.A., Ph.D., A.M.I.M.M.

A new appointment in the Traction Division of Associated Electrical Industries Limited is that of **Mr. J. H. Elvin** as assistant superintendent, traction manufacturing department. Another appointment is that of **Mr. D. Major,** B.A., B.Sc., as assistant chief engineer of the X-ray Department of the Instrumentation Division of A.E.I.

In connection with the formation of the new research and development department of Diversey - Deosan chemical and bacteriological laboratories, the following appointments have been announced:—**Mr. R. E. Chandler,** M.Sc., to be technical manager; **Mr. R. H. Vickers,** B.Sc., to be chief chemist; and **Mr. E. Roitt,** B.A., to be industrial section supervisor.

Various appointments have been made recently in the organization of Associated Electrical Industries Limited. **Mr. E. Heys,** A.M.I.E.E., has been appointed manager, electronic sales department (Manchester) of the AEI electronic apparatus division. **Mr. R. Crummack,** B.Eng., has been appointed superintendent (process and rate) at Manchester, and **Mr. R. G. Nicholas,** Grad.I.Mech.E., appointed superintendent (production engineering service), also at Manchester. Both these gentlemen are in the manufacturing services department. The personnel services of AEI (Manchester) Limited have also been re-arranged. **Mr. J. S. Butterworth,** M.I.P.M., is to be labour manager; **Mr. H. Walker,** M.A., staff manager; **Mr. B. Dawkins,** B.Sc., A.M.I.E.E., A.M.I.Mech.E., education manager; and **Mr. R. F. Jones,** B.A., to be chief information officer.

Aluminium Alloys For Deep Drawing

By C. J. SMITH A.I.M.
(*Technical Director, Birmetals Ltd.*)

(*Continued from* METAL INDUSTRY, 9 *June*, 1961)

IN hot working, the purpose of hot breaking down of the cast slab ingot is to eliminate the dendritic structure and produce a more malleable material which will be more amenable to subsequent cold reduction. Reductions are, therefore, effected within such a temperature range and at such a rate as to obtain maximum deformation with minimum tendency to cracking on the surface or within the product.[22]

Surface quality of the hot rolled blank is most essential in stock destined for manufacture into drawing quality sheet. It is, therefore, good practice to start with well scalped slab ingot in those alloys which are likely to exhibit near-surface segregates since the presence of these in the finished sheet may give rise to open "spill" on drawing.

The factor chiefly affecting blank surface quality is the coefficient of friction between the rolls and the metal. This is a complex function of temperature, rolling speed, reduction per pass, lubricating conditions and dimensions of both rolls and workpiece. These, in relation to the alloy type, govern the condition of the aluminium coating, which should be maintained on the roll surface throughout to ensure successful rolling. Inspection at this stage for rolled-in oxides and burnt lubricant can prevent unsatisfactory material for critical jobs being processed without further attention. Indeed, in the production of so-called "anodizing quality" sheet[23] and strip, mechanical or chemical treatment of the hot-rolled surface may be introduced at this stage. Other devices which may be employed include the continuous scrubbing of the mill surface during rolling so as to keep the coating free from picked up oxide.

Cold Reduction and Annealing. Below a thickness which will vary from works to works according to initial slab size and rolling mill capacity, but which may be taken by way of example as about ¼ in. to ½ in. thick, further reduction will be carried out below the recrystallization temperature, though not always at room temperature, and intermediate anneals will be applied where necessary.

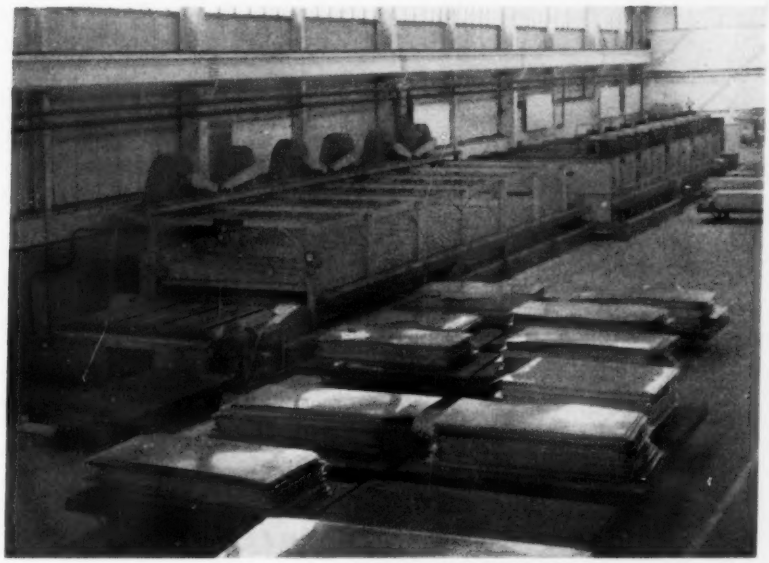


Fig. 8—General view of flash annealing furnace and cooling chamber

Reduction between anneals will vary from alloy to alloy and according to available plant but will be in the general range of 30 to 80 per cent, the aim being to secure economy of production yet to avoid the dangers inherent in inducing preferred orientation effects or coarse grain growth phenomena. Further mention will be made of these features later.

It is rare these days to find sheet products receiving a significant amount of cross rolling on the cold mills, although turning of the cast slab at the breaking down stage is still found to be advantageous. In this respect, the light alloy industry is clearly following steelworks practice.

Little purpose would be served in this review by quoting precise rolling and annealing schedules. It might, perhaps, be mentioned that full annealing is generally achieved at a selected temperature within the range 300°-450°C. The exact temperature will depend on alloy, previous reduction, type of furnace used and rate of heating to temperature. A temperature control of better than ±5°C. and a time control within a few seconds may be needed for conveyor band flash annealing[24] of critical products. Furnaces for the continuous progression of coils have also been built; both types are shown in Figs. 8 and 9.

Fig. 9—Batch progress coil annealing furnace

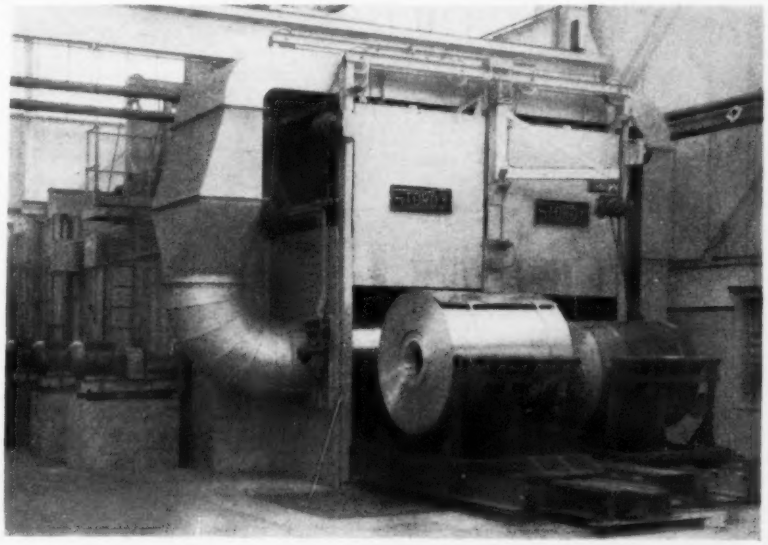


TABLE III—TYPICAL PROPERTIES OF ALUMINIUM-MAGNESIUM TEMPER MATERIALS

Alloy		Temper Rolled			Partially Annealed		
		0·1 per cent P.S. tons/in²	U.T.S. tons/in²	Elongation per cent on 2 in.	0·1 per cent P.S. tons/in²	U.T.S. tons/in²	Elongation per cent on 2 in.
Al + 0·6 per cent Mg	¼ Hard	8·5	9·7	6	7·2	9·3	15
	½ Hard	10·0	12·1	4	9·3	11·1	10
Al + 2 per cent Mg	¼ Hard	11·7	13·7	9	11·0	14·0	15
	½ Hard	13·5	16·0	6	13·2	15·9	12
Al + 3·5 per cent Mg	¼ Hard	13·6	17·5	9	12·0	17·0	15
	½ Hard	15·8	19·3	6	15·3	19·1	12

All test samples transverse to rolling direction

Final Tempers. Temper sheet can be produced conventionally by specific reduction from previously annealed material or it may be given a "partial anneal" following the imposition of a previous controlled reduction.[25,26] In the latter method, the worked sheet is subjected to heating such that the recovery process develops to the required degree whilst avoiding any tendency to recrystallize. The scope for such treatments and the obvious need to control both time and temperature conditions with accuracy if a narrow range of properties is to be achieved are indicated in Fig. 10.

Comparison between typical results of both methods for temper sheet production of aluminium-magnesium alloys is given in Table III. The principal differences to be noted are the slightly modified proof stress/ultimate stress ratios for the partially annealed condition and the substantially better ductility. This is of definite advantage in the production of shallow pressed parts. For many operations involving simple forming and bending, either material may be chosen with impunity without fear of rejections; indeed, the partially annealed sheet may give slight advantages not previously recognized. For slightly deeper pressings, more care may require to be exercised since the degree of "earing" in those materials subject to this phenomenon may be affected by a change in technique.[27]

With proper control, the method of partial annealing, even when performed in continuous furnaces or in batch progress ovens can give sheet with uniformity of properties from batch to batch at least as good as for temper rolling. Indeed, temper rolling is not without its difficulties. These are most acute in the case of the more strongly work-hardening alloys which need extremely close control of the small reductions needed to attain the quarter-hard tempers. Accuracy of gauge reduction needs very careful attention both to the individual final stage passes and to the sheet shape from the previous working, and assumes greater importance as the size of the sheet increases. Strip rolling has obvious advantages here, although some benefit can be obtained on single sheets by rolling on four-high mills.

Differential Annealing. This is a modernized adaptation of the old practice of the metal smith who flamed a local area while his assistant plied wet cloths to the main body of the worked article so that further local operations could be performed.

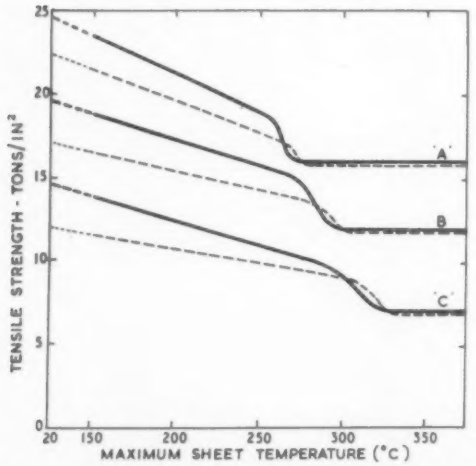
The chief features of the process, which provides annealed properties in those areas where work is to be performed, yet retains other areas in the near-hard condition, have been described in the literature.[28,29]

There appear to be two practical methods of achieving the desired end. Both give quite sharp distinction between hard and soft areas, a desirable feature for some purposes, and both are capable of sufficient control to make them useful production processes.

One method involves clamping the worked sheet between chilled surfaces having an area near to that required to remain hard, whilst heat is applied to the free area. The operation can be time and temperature controlled and can be made fully automatic if suitable care is exercised in the engineering to prevent damage to the sheets on transfer. It is also an advantage to rotate the blanks during heating. With this method, a limited variety of shapes for the harder central area is possible. There are a number of minor variants of this method whereby sheet can be produced suitable for deep drawn containers which have a flat base in which negligible stretch-forming occurs. Such containers will have obvious better durability in service than those made from fully softened sheet.

Similar results, but with rather greater scope for variation of hard and soft area patterns, can be achieved by utilizing the principle of differential absorption of radiant heat by surfaces having different emissivity. For example, a bright sheet partly coated with a matte black surface coating, if passed through a closely controlled radiant heat and forced-air circulation furnace at a predetermined speed will develop fully annealed properties only in the blackened areas. Very satisfactory results have been obtained using a method which should lend itself somewhat better to volume production if the ancillary coating and coat stripping equipment is properly engineered. The possibilities of this method in

(*Continued on page* 480)



A—Aluminium-3·5 per cent magnesium. B—Aluminium-2·0 per cent magnesium. C—Aluminium-0·6 per cent magnesium

Fig. 10—Curves showing typical relationship between strength and annealing temperature in conveyor furnace annealing (indicating possibilities of partial annealing)

Reviews of the Month

NEW BOOKS AND THEIR AUTHORS

VACUUM TECHNOLOGY

"Vacuum Technology Transactions." *Published by Pergamon Press Ltd., Headington Hill Hall, Oxford, for the American Vacuum Society. Pp.* 444. *Price* 147*s.*

THE amount of information contained in the 1960 Transactions of the American Vacuum Society makes writing of a short review difficult because so many points in the seventy-three Papers submitted are worthy of individual mention. Whilst the scope of the Symposium is wide, emphasis in the main is towards ultra high vacuum and the progress recorded is impressive.

Considerable attention has been paid to pumps, and two interesting mechanical pumps are described. One is a Gaede molecular pump, in which both suspension and rotation of the rotor are achieved electromagnetically, thus eliminating shaft seals. The second is an experimental bladed axial flow pump similar to the well-known axial flow compressor, and results obtained with this are encouraging. Ion and getter ion pumps are dealt with in a number of Papers, and significant improvements have been achieved; additional light thrown on the mechanism of these pumps should make still further improvement possible.

However, the most effective means for production of very low pressures still appears to be the oil diffusion pump, and details are given of improvements in design which have achieved a considerable increase in pumping speed and reduction in back-streaming. Inevitably, traps have received attention and non-refrigerated types utilizing artificial zeolite are described; the degree of clean-up of oil vapour and long effective life obtained with these is surprising.

A review of the efficiency of ideal and actual ejectors is presented, together with information regarding the use of steam ejectors for large metallurgical equipment operating in the low micron range. Operating experience demonstrated that these were superior to oil vapour booster pumps both as regards performance and cost.

Vacuum system components have received attention, and details of all metal valves and joint seals of sound design are given. Improved elastomer sealing materials which have reduced outgassing characteristics and can be heated at temperatures up to 150°C. have also been investigated.

Considerable work is reported in connection with improved accuracy of measurement at ultra low pressures, and effort has been exerted towards reducing or eliminating atmosphere composition changes caused by the presence of hot filaments. Information is also presented regarding adsorbtion and desorbtion effects, and further light is thrown on the Blears effect. Gas analysis equipment described includes instruments based on the r.f. mass spectrometer, and one of these is arranged to scan the spectrum at 50 cycles/sec., presenting the results on a cathode ray oscilloscope and thus enabling changes to be observed as they occur.

A section of the Symposium is devoted to studies of the properties of thin films, sputtering, vapour deposition, evaporation, etc., and two microbalances designed for use in vacuum chambers are described; freeze drying and molecular stills are also covered.

In conclusion, it can only be emphasized that this Symposium forms a valuable addition to the mounting store of vacuum technology literature.

T. T.

PLATINUM

"A History of Platinum." *By D. McDonald. Published by Johnson, Matthey and Co. Ltd., Hatton Garden, London, E.C.*1. *Pp.* 254. *Price* 35*s.*

IT IS generally accepted that political affairs can only be properly and efficiently managed by those who have made a close study of the political history of the world. It is less widely appreciated that a similar dictum applies, perhaps in varying degrees, to most fields of human activity, including, in particular, the study of scientific matters. A careful reading of this book will, however, convince all metallurgists that there is much to be learnt from the endeavours of our predecessors.

Platinum is a metal which is now accepted as one of the most readily-worked materials, easily fabricated into the common forms of sheet, wire or gauze in which it is widely used and valued for its exceptional chemical and physical characteristics. Towards the end of the eighteenth century, however, when platinum had been known to scientific circles for about 50 years, Chabaneau, working in Madrid under royal patronage, was at one time so incensed at the difficulty of obtaining consistent ductility that he flew into a frenzy and threw all his equipment and materials out of the window (at that time, platinum was available at between 4s. and 5s. per oz.) saying "Away with it all! . . . you shall never again get me to touch the damned metal".

Those of us currently concerned with more modern, but apparently equally capricious, metals should take heart, for within three months, Chabaneau produced a beautiful ingot weighing 23 kg., and it was his metal that was used for the platinum chalice presented by Charles III of Spain to Pope Pius VI and now in the Treasury at St. Peter's, Rome. It was about this time, and presumably as a consequence of the successful taming of the metal, that the name was gradually changed from "la platine" to "le platine" and from "die Platina" to "das Platin".

This beautifully produced book covers the history of platinum from the earliest identifiable references up to the end of the nineteenth century, and is written in a style that makes it a genuine pleasure to read, for the author, while fully appreciating the technical basis of the subject, has the capacity to compose a lucid and entrancing text. The book is lavishly illustrated and will be a valued possession of those fortunate enough to obtain a copy.

W. B.

SHEET AND STRIP

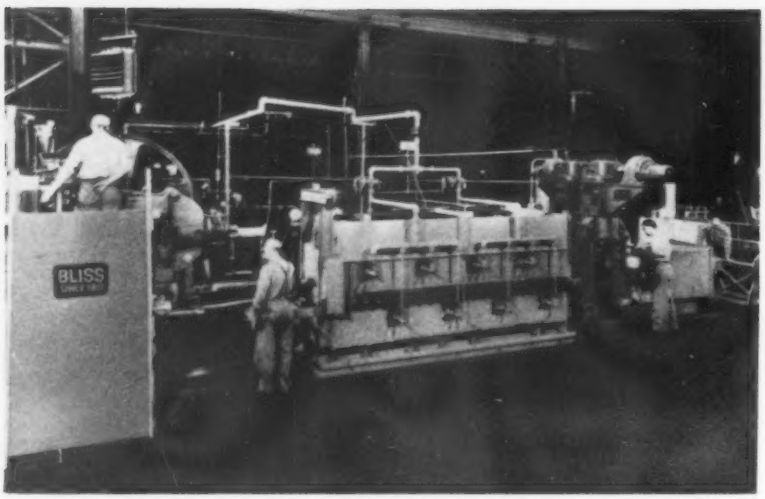
"Textures in Metal Sheets." *By F. A. Underwood. Published by Macdonald and Co. (Publishers) Ltd.,* 16 *Maddox Street, London, W.*1. *Pp. xii*+148. *Price* 28*s.*

THE production of strip and sheet is very big business, for these materials are generally the starting point in the manufacture of a vast range of articles from pans to refrigerators or from cans to motor-car bodies. It has been known for a long time that preferred orientation or textures in strip leads to undesirable directionality in plastic behaviour and the main concern of the metallurgist was, as far as possible, to avoid textures and consequent directionality. More recently, however, it has been shown that the right sort of texture can lead to better drawing quality or even impart reasonable ductility to beryllium, which some pessimists once thought could never be produced in ductile form.

There is, therefore, a double technical interest in textures quite apart from a most intriguing academic interest in connection with the theory of deformation and recrystallization of metals.

The author's monograph thus meets the needs of students and industrial research workers in an important although highly specialized field. The book is a short, simple yet competent review of the subject, bringing out all the essential points with ample references to fuller texts for those wishing to delve deeper into the subject. It is concerned mainly with the experimental and theoretical aspects; the technical significance of the effects of preferred orientation and how they may be overcome are not given the emphasis they deserve.

The author has prepared his material with meticulous care, but it is apparent that he has been out of touch with the subject for some time, otherwise he would not have allowed an unacceptable description of a rolling texture to have



In the projected plant being laid down in the Philippines for the production of high quality copper from low grade ores, one of the steps in the process is the direct rolling of strip from copper powder. The equipment, which has been developed and built by the E. W. Bliss Company, is shown in this illustration. Metal powder is fed from the hopper at top left, enters the compacting rolls, and then goes through sintering furnace and hot mill rolls.

appeared on p. 60, namely (123) [121] as the rolling texture of copper.

The general standard of presentation of the book is very good, although the reproduction of X-ray photographs is shockingly poor and spoils an otherwise attractive publication.

However, the reviewer can commend this monograph to all technical libraries and, at the price, it is good value to all workers having an active interest in the subject.

T. Ll. R.

METALS DATA

"Metals Handbook." *8th edition, Vol. 1—Properties and Selection of Metals. Published by American Society for Metals, Novelty, Ohio. Pp.* 1300. *Price* $30.00.

THE new A.S.M. Metals Handbook is devoted exclusively to the selection and properties of metals and is the first of a projected series of volumes which, when completed, will cover all branches of metals engineering and metalworking.

A greatly enlarged section on carbon and low-alloy steels consists of 26 major articles—12 on steel products and 14 on selection for specific engineering properties, economy, and special processing considerations. Included in this 286 page section are articles covering all commercial steel product forms, and articles dealing specifically with selection for maximum yield strength at minimum cost, hardenability, fatigue resistance, notch toughness, wear resistance, and resistance to corrosion.

Major processing factors are covered in articles on selection for economy in machining, selection of low-carbon steel sheet formability, deep-drawing, and porcelain enamelling—to mention only a few of the highlights.

Many articles dealing with metal selection for specific engineering properties are entirely new. The section on stainless steels now provides ample coverage of all stainless steels (cast and wrought), including the more recently developed precipitation-hardening alloys. A major section on tool materials includes 18 articles on 18 specific types of tools. Aluminium, copper and the other major non-ferrous metals are amply covered. Other sections are devoted to iron-base superstrength alloys, nickel-base and cobalt-base alloys, titanium and titanium alloys. More pages than before are assigned to magnetic, electrical, and other special purpose metals, precious metals, and—a subject of rapidly expanding interest—the properties of pure metals. A glossary of 2,800 definitions appears at the front of the book.

SCIENCE FOR PLATERS

"Elementary Science for Electroplating Students and Foremen." *By E. A. Ollard. Published by Robert Draper Ltd., Teddington. Pp. x+99. Price* 18*s.*

OVER the past four or five years, considerable effort has been directed, by the plating industry and its representative bodies, towards the better training of apprentices in the industry. These efforts have not, it must be admitted, met with the hoped-for success, and the plating industry is still, so far as jobbing work is concerned, faced with a shortage of young men with both practical experience and theoretical knowledge. This book attempts to fill one of the needs felt by the practical man in that it sets out to provide him with the elementary knowledge of science he may need in order to study further.

This is a worthy project; it is, however, difficult to fulfil the requirements demanded. Simplicity is essential, clarity all-important, and unnecessary repetition to be avoided. How far the first requirement may be said to have been met depends to a great extent upon the level of simplification considered advisable, and here it should be remembered that this book is largely for operatives, so that extreme simplicity is, perhaps, essential. On the score of clarity, the book is reasonably good, but it is to be hoped that in any subsequent editions some of the repetition will be suitably edited.

All this, of course, does not diminish the value of the information the book contains, and there is little doubt that it will prove of value to a great many whose education has not given them basic science and who wish to know more about the fundamental electroplating processes.

Under the chapter heading "Principles of Chemistry", the atomic structure of matter is introduced: molecular weight, states of matter, valency, Faraday's Laws and metals are discussed briefly. Chapter 2 deals with "Principles of Chemical Analysis", and Chapter 3 with "Principles of Electricity". Chapter 4 covers "Principles of Electrochemistry", and touches on such subjects as electrolytic cells, migration of ions, current efficiency, cathode and anode efficiencies, polarization, throwing power, etc. "Properties of Electrodeposits" are dealt with in Chapter 5, and Chapters 6 and 7 deal with "Units of Heat" and "Plating Calculations" respectively. An appendix contains some useful tabular and reference material.

Aluminium Alloys for Deep Drawing

(*Continued from page* 478)

producing sheet with graduated annealing patterns which could have practical value, by the use of coatings of different emissivity characteristics, will be readily appreciated. Certain aspects of differential annealing are protected by patents.

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(To be continued)

Industrial News

Home and Overseas

Non-Ferrous Club

Urging manufacturers and metal merchants to take every precaution against metal theft, **Superintendent G. H. Baumber,** deputy head of the C.I.D. in Birmingham, was the guest speaker at the club's monthly luncheon, held on Wednesday of last week at the Queen's Hotel, Birmingham. He stressed the importance of having individual marks on metal, especially the shafts of anodes, avoiding loaded lorries being unattended, of suitable burglar alarms and other safety measures.

Following the lunch, a collection was taken on behalf of the Police Aided Association and the sum of £16 6s. 0d. was realized. Members of the club were reminded of the golf meeting to be held on June 20, and also of another evening engagement on September 28 at the Greswolde Hotel, Knowle, when a "Men Only" dinner will be held.

New Forth Road Bridge

It has been announced that **Charles Clifford Ltd.,** of Birmingham, have been awarded contracts for the supply of zinc wire for metal spraying the surfaces of the fabricated steelwork to be used in the new Forth Road Bridge, at present under construction. The specification for the wire is as follows: "Seacliff" brand zinc wire, 99·95 per cent minimum purity, $\frac{1}{16}$ in. dia + nil − 0·002 in., in endless coils weighing approximately 5 cwt. each.

The wire is carried in specially designed heavyweight returnable containers with close fitting quick release lids and which are moisture proof, thereby enabling the wire to be kept in perfect condition, under almost any conditions of storage on site. The supply feed to the automatic metal spraying equipment is direct from the container and the construction of the containers renders them readily transportable.

The contract for the superstructure of the bridge is being undertaken by The A.C.D. Bridge Company, a consortium formed by Sir William Arrol and Co. Ltd., The Cleveland Bridge and Engineering Co. Ltd., and Dorman Long (Bridge and Engineering) Ltd. About half of the metal spraying will be carried out at The A.C.D. Bridge Company's depot at Drem, East Lothian, Scotland, using automatic metal spraying equipment, designed and manufactured by Charles Clifford's associated company, Metallisation Ltd. The remaining work will be carried out at the works of The Cleveland Bridge and Engineering Co. Ltd. at Darlington, and it is estimated that about 450 tons of wire will be used in connection with the project. The Bridge is being constructed for The Forth Road Bridge Joint Board, and the engineers are Mott, Hay and Anderson and Freeman, Fox and Partners.

Aluminium Grandstand

Aluminium was used extensively, in a variety of applications, for one of the most impressive pieces of civil engineering and architecture in New Zealand — the new 315 ft. long grandstand at the Auckland Racing Club's course at Ellerslie. Here, the atmospheric environment—salt-laden and with seasonal high winds — makes severe demands on any structure of this kind. The requirements called for a functional design of modern aspect with particular emphasis on structural strength, corrosion resistance and low maintenance costs.

Designed by Wilson, Moodie and Gillespie, architects, of Auckland, and built at a cost of £500,000, the stand consists of two seating galleries for about 4,000 people, with six storeys of amenity accommodation — offices, dining rooms, bars, totes and elevators — at the rear. Gray, Watts and Beca were the construction engineers.

The main vertical members, carried down and fastened into the natural blue stone, some 30 ft. below ground level, support a welded tubular steel space frame which forms a fully cantilevered structure for both the amenity accommodation and upper seating gallery canopy, giving an unsupported projection of 45 ft. and 60 ft. respectively. Despite this comparatively light construction, a load of 400 tons was calculated for each of the main supports —including allowances for high winds and earthquakes. The roof is sufficiently low pitched to afford weather protection and at the same time to allow rainwater to be shed to the back.

Noral "Industrial" profile stucco-embossed corrugated aluminium sheet, supplied by **Alcan Industries Limited,** was used for the roof cladding. This was fixed under the roof framing and purlins to eliminate bird nuisance by giving them no place inside on which to perch. The aluminium sheets were fixed by studs fired into the purlins. A bitumen-felt strip was laid between the zinc-sprayed steel purlins and aluminium sheet to protect the sheet from galvanic action, and a special washer was placed between the fixing studs and sheeting for the same purpose.

The back of the stand is clad with aluminium curtain walling with sprayed asbestos-cement infilling panels. The end walls are of stucco-embossed Noral "Snap-rib" sheet, anodized gold. Other applications utilizing aluminium include balustrades of Noral "Industrial" sheet backed with stucco-embossed sheet on the inside; capping and associated hardware; light fittings, door handles and restaurant appliances. The illustration on this page gives a general view of the new grandstand, showing the impressive spread of the aluminium canopy.

U.K. Export Controls

A number of changes in export licensing were announced by the Board of Trade last week-end, and these came into force on Tuesday last.

Export control is removed from molybdenum disulphide, while the descriptions of goods to which export control applies have been amended to include molybdenum and niobium (columbium).

These changes in export controls are, in the main, consequential on a number of amendments to the list of goods subject to embargo for the Soviet Bloc and Mainland China published by the Board of Trade at the beginning of May.

Aluminium Van Trailer

A 40 ft. tandem axle open top van trailer, which can be converted to a flat bed unit in 20 minutes by removing the aluminium side panels, is reported from Los Angeles. This has been designed and built by the Pike Trailer Company, of that city, and the unit can transport a wide variety of commodities and equipment.

The seven-foot removable panels, which are stored in the front compartment when not in use, are made of 2024 aluminium alloy sheet and 6062 alloy extrusion. Loading space in the van is 2,625 ft^3. Frame deflection under a 30 ton load is 1 inch maximum.

Italian Copper Imports

According to statistics from Rome, Italian imports of crude copper during the first two months of 1961 amounted to 6,241·4 metric tons valued at 2,353,807,000

A general view of the Auckland Racing Club's new grandstand showing the impressive spread of the aluminium canopy

lire, of which 516·0 metric tons were temporary imports. The principal suppliers were Rhodesia and Nyasaland with 1,957·3, South Africa 1,578·9, and the U.S. 2,629·0 metric tons.

Imports of refined copper in slabs, plates, ingots, etc., during the first two months totalled 32,013·5 metric tons valued at 12,096,869,000 lire, of which 3,493·9 were imported temporarily. The main suppliers during the period were the U.K., with 1,886·6, the Congo Republic 5,442·3, Rhodesia and Nyasaland 5,027·9, the U.S. 10,575·6, Canada 2,170·6 and Chile 2,037·5 metric tons.

New Department

According to news from **Diversey (U.K.) Ltd.** and its associate company, Deosan Ltd., the Diversey-Deosan chemical and bacteriological laboratories, which previously operated as separate units, have now been amalgamated to form one joint research and development department. This department will be responsible for all research, development and laboratory work for the four divisions of the company.

Fuel Efficiency

The eighth annual refresher course on "Current Practice in Fuel Efficiency" is to be held at the Clarendon Laboratory, Oxford, from September 25 to 29 this year. This has been organized by the **National Industrial Fuel Efficiency Service** with the support of the Southern Regional Council for Further Education.

Preliminary programmes and registration forms may be obtained from the N.I.F.E.S., South-Western Area, Ailsa House, 181 Kings Road, Reading.

Internal Stress

A one-day Symposium on "Internal Stresses in Electrolytically Produced Coatings and Their Influence on the Properties of the Basis Metals" has been arranged by the **Borough Polytechnic** to take place on Thursday, July 6 next. The event will open at 10 a.m. and continue until 5.45 p.m.

The fee for the day is £2 2s. 0d., which includes lunch, morning coffee and afternoon tea, and details and application forms may be obtained from the secretary, Borough Polytechnic, Borough Road, London, S.E.1.

Grey Iron Castings

A booklet issued by the **National and Midland Ironfounders' Association** draws attention to the properties and varied applications of grey iron castings. Its purpose is to assist buyers, designers, draughtsman and others concerned in the specification of materials, to assess more accurately the merits of iron castings. In addition to setting out some interesting modern applications of cast iron, certain tables and basic information are contained in this publication. There are also a number of excellent illustrations.

Export Credits

It is reported that the Leeds office of the Export Credits Guarantee Department has moved to a new address at Headrow House, 42 The Headrow, Leeds, 1. The telephone remains the same at Leeds 30082, and the office is under the managership of Mr. W. E. Smith.

Postgraduate Courses

For the Autumn Term, 1961, the College of Advanced Technology, Birmingham (Department of Metallurgy) has arranged two post graduate courses as follows: (a) Practical Implications of Metal Physics; a course of ten lectures by leading authorities, on Tuesday evenings, commencing on October 10 next. (b) Technology of Non-Ferrous Secondary Metals; a course of ten lectures on Wednesday evenings, commencing October 11 next. Topics covered will include surveys of non-ferrous metals and alloys, sampling and sorting, melting and refining techniques, and commercial practice.

Full details of the programme may be obtained from the Bursar of the College at Gosta Green, Birmingham, 4. The fee for each course is £2 10s. 0d.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 175 tons to 8,734 tons, comprising London 4,154, Liverpool 3,436 and Hull 1,144.

Copper stocks rose 350 tons to 16,877, distributed as follows: London 600, Liverpool 13,702, Birmingham 50, Manchester 2,500 and Hull 25.

Lead duty-free stocks fell 175 tons to 7,600 tons, comprising London 7,496, Glasgow 4 and Swansea 100. In-bond stocks fell 50 tons to 3,793 tons, all in London.

Zinc duty-free stocks fell 262 tons to 4,976, comprising London 3,758, Glasgow 90, Manchester 500 and Liverpool 628. In-bond stocks rose 77 tons to 2,750, all in London.

Soviet Metals for Cuba

According to the Soviet news agency Tass, the Soviet Union is to supply Cuba with rolled steel and non-ferrous metals under contracts which were signed in Moscow recently.

Golf Meeting

Advance notice is given of the Autumn Meeting of the **National Association of Non-Ferrous Metal Merchants' Golfing Society,** which is to be held on Thursday, October 5, at the Copt Heath Golf Club, Solihull, Warwickshire. A dinner will be held the previous evening at the Midland Hotel, Birmingham.

London Sales Office

Due to continued expansion, the London sales offices of the **Evode Group** of companies are moving on Monday next to larger premises at 450/452 Edgware Road, W.C.2. The new telephone number is Ambassador 2425.

The storage facilities at Greenford have been enlarged to cater for the continued heavy demand for the group's products, which include Evo-Stik "Impact" adhesives, Evomastic sealing compounds and chemical products.

Crack Detection Equipment

An order has been received by **Associated Electrical Industries Ltd.** from West Germany for a Metroflux type "T" universal magnetic crack detector. This equipment, designed by AEI Instrumentation Division to detect surface cracks and flaws in magnetic materials uses the principle that in such materials a magnetic field will be distorted in the neighbourhood of a fault.

The type "T" unit, which is to be supplied to Klackner Humboldt Deutz, of Cologne, is designed for testing, on a production basis, gas turbine aero engine discs up to 42 in. diameter with or without blading, and shafts up to 6 in. diameter and 84 in. long. A combination of A.C. and D.C. methods of magnetization and multiple adjustable pole pieces enables all types of surface cracks to be revealed, whatever their direction.

Direct Melting

London area members of the **Association of Bronze and Brass Founders,** at their meeting at Hammersmith last week, were privileged to hear the challenging views and experiences of Mr. W. B. Lawrie, M.B.E., H.M. Engineering Inspector of Factories, on the melting of non-ferrous metals and to question him on this subject.

Mr. Lawrie described investigations and experiments in direct melting carried out with the co-operation of members of the industry, stemming from the demand in the Joint Standing Committee on Non-Ferrous Foundries for cooler working conditions and a reduction of fume. From his background of steelmaking, he had the feeling that non-ferrous founders did not know how to melt! The efficiency of present melting methods was low, about 13 per cent for a bale-out furnace; 87 per cent of the heat went into the foundry which then had to be expensively extracted. The ideal was to melt rapidly and pour immediately. Direct melting had been considered impossible, and immediate pouring meant moulds should be ready and waiting for the metal—a reversal of non-ferrous practice.

Experiment furnaces or melting chambers had been constructed. The first raised fuel efficiency to 31 per cent, the second raised fuel efficiency to 44 per cent, melting 16·7 lb. of aluminium per minute with oxy-propane gas. With the help of the N.E. Gas Board, a practical version of the melting chamber had been developed, known as the A.C.R.M. (Atmosphere Controlled Rapid Melting) Furnace, details of which were given in a Gas Board leaflet; this, without the use of preheated air, which should give additional economies, melts 100 lb. of bronze in 7-11 minutes at a fuel cost (gas) of 22s. 3d. and with greatly reduced metal loss.

Mr. Lawrie looked for much better results by using smaller furnaces melting in controlled cycles. He dealt with members' questions very frankly and urged them to develop melting chambers, starting from the ideas given and adapted to their own conditions.

The talk was preceded by the British Steel Founders' Association film "Your Eyes are Precious", and was followed by a discussion of promotion activities and arrangements for the Autumn meeting, to be held on September 13 next.

Open Days at R.A.E.

On Friday and Saturday last, the **Royal Aircraft Establishment** at Farnborough staged a series of exhibits showing the wide variety of work being undertaken. Apart from chemistry, physics and metallurgy, demonstrations and examples of work in progress were arranged by the departments concerned with aerodynamics armament, electrical engineering, experimental flying, guided weapons, instrumentation, air photography, mathematics, mechanical engineering, radio, structures, trials, and engineering services.

Among the exhibits dealing with metallurgy and physics were examples showing the development of new artificial graphites and carbons, work on the fatigue and fracture of metals, including a display of typical fractures, the testing of aluminium alloys for supersonic transport aircraft and the development of titanium alloys and brazing techniques for titanium. In this last-mentioned field, the best brazing alloy has been found to be

titanium - 5 per cent aluminium - 1·5 per cent boron-0·3 per cent carbon. Honeycomb structures vacuum brazed at 650°C., using a 69 per cent aluminium-30 per cent silver-1 per cent nickel (or manganese) were also on show in this section.

Hardness Testers

Since its introduction 54 years ago, the Shore Hardness scale has become well known and the measuring instrument, the Scleroscope, very widely used in industrial mass production and engineering. Two instruments are marketed on behalf of the Shore Instrument and Manufacturing Company, of New York, by their sole agents for the United Kingdom and the Commonwealth (except Australia), **Griffin and George (Sales) Limited.**

The new Shore Scleroscope, model C.2, is an improved, direct-reading instrument, simple and fast in use, for the testing of thin metal sheets such as hardened steel (from 0·006 in. thickness), cold rolled unannealed brass and steel (from 0·010 in.) and annealed sheets (from 0·015 in. thickness). It is also suitable for the testing of chilled iron, forged rolls, gears, axles and other machined parts.

The model D Scleroscope substitutes a dial and pointer for the reading of hardness numbers instead of the vertical scale behind the hammer tube. The dial, being also graduated in Brinell and Rockwell C hardness numbers, facilitates direct reading in any of the three scales desired. It is understood that this model will test all the materials for which the model C.2 is suitable, such as razor blades, large die blocks, shafting, crankshafts, machine tool ways, railway wagon wheels and so forth. It is not recommended, however, for use freehand. A selection of clamping devices is available.

Swedish Aluminium

According to recent news from Stockholm, Svenska Metallverken, one of Sweden's leading producers of non-ferrous metal semi-manufactures, have acquired the remaining 50 per cent of the shares of Svenska Aluminiumkompaniet, from Aluminium Ltd., of Canada. The take-over sum is Kr. 38,500,000.

Svenska Aluminiumkompaniet, which has smelting-works at Kubikenborg and Avesta and produces about 16,000 tons of crude aluminium a year, was a wholly-owned subsidiary of Aluminium Ltd. until 1949, when Svenska Metallverken acquired 50 per cent of the shares. The purchase of the remaining shares under the present deal has been paid for by a promissory note. However, Metallverken intends to exchange this note for 230,000 new B shares at a rate of Kr. 165 per share, each entitling to one-tenth of a vote, to be issued this autumn.

Construction Equipment Display

Opened yesterday (Thursday) by the President of the Board of Trade, at the Crystal Palace, London, S.E., the **International Construction Equipment Exhibition** will remain open until Saturday, June 24. This exhibition provides a most comprehensive display of plant, machinery and equipment. Over 170 exhibitors are showing equipment ranging from the smallest hand mechanical power tools to the largest earth-moving machinery.

Reference and Information Chart

A most useful reference chart dealing with aluminium and aluminium alloys has been produced by **London Metal Warehouses Ltd.** Within the space of twelve pages, details of British Standard Tables are given, also average weights of aluminium sheets and alloy round rods, etc., commercial tolerances for aluminium sheets, round rods, aluminium alloy tubes, and brief notes of some of the available specifications of aluminium alloys.

Other useful data are included, and copies of this chart may be obtained on application to the company at Summer Road, Thames Ditton, Surrey.

Oxyplane for New Steel Works

An Oxyplane machine has been installed in the new South Works of the South Durham Steel and Iron Co. Ltd., West Hartlepool. The machine, installed by **British Oxygen** to trim plates coming off the new rolling mill, has a track length of almost 100 ft.

Using propane as the fuel gas, the Oxyplane can trim plates up to 97½ ft. long, 12½ ft. wide, between ¾ in. and 4 in. thick, and gives a square edge bevel, double bevel, or double bevel and nose finish. Cutting speeds of up to 50 ft/hr. through 2 in. thick steel have been achieved.

Canadian Aluminium

A major portion of the aluminium forge plant at Kingston, Ontario, will be closed down gradually after present orders are filled, it has been announced by Aluminum Company of Canada Limited. The plant was built in 1941 as a war plant to supply high-strength forgings for military aircraft. Following the war, Aluminum Company of Canada maintained the forge as a possible aid to defence and tried to find peacetime markets. No such markets were forthcoming, officials said.

Long Service Records

There is probably no company which does more to show its appreciation of long service than **Garringtons Limited,** of Darlaston and Bromsgrove. This company, employing upwards of 4,000 people, has already become well-known for its "40 Years' Club" created some ten years ago, and, more recently, the "Evergreen Room" for the use of retired members at the company's Darlaston works, both inaugurated by its chairman, Mr. R. P. Brookes.

Recently, the fourth "Garrington's Long Service Dinner" was given by the chairman at the Grand Hotel, Birmingham, for 125 guests; amongst them were 36 members with over 40 years' service and 81 with 25 years or more, making a total of 117 persons whose combined years of service totalled 4,046 years.

This, however, was an unique occasion, as, in the words of the chairman, they were there to recognize (by the presentation of certificates and timepieces) 23 employees who had recently completed 25 years' service, and two very special members, who had now become eligible for the "40 Years' Club"; one of these, Mr. J. Spellman, was a workman who had done almost every job in the forge, from stamper to shop foreman, whilst the second was the company's director and general manager, Mr. J. C. Beech.

New Metal Spray Pistol

Forty-two representatives from twenty-three North Eastern companies recently watched a demonstration of the new Berk 61 metal spraying pistol at the Middlesbrough works of Dorman Long (Bridge and Engineering) Co. Ltd. The demonstration was organized by the Coating Division of **F. W. Berk and Co. Ltd.,** who have developed the Model 61 pistol to meet the needs of contractors who need fast spraying equipment either to cover large areas of structural steelwork or to match in with automatic grit-blasting installations.

The Berk 61 pistol, it is understood, will deposit zinc powder with a deposi-

F. W. Berk demonstrating their new model 61 metal powder spraying pistol to North Eastern engineers at the Middlesbrough works of Dorman Long (Bridge and Engineering) Co. Ltd. Spraying rate of the model 61 (left) is matched against that of the model 50

tion efficiency as high as that obtained with a 35 p.p.h. pistol, with the same gas and air consumption, but at a rate of 110 lb/hr. This is approximately equivalent to the deposition of 0·004 in. coating over 650 ft²/hr. This performance is achieved by means of the patented nozzle, which projects powder, gas and air through alternate and concentric jets. This nozzle, which can be cheaply and easily replaced, is the only part of the pistol which can require maintenance. As the pistol is intended for large scale spraying, it is correspondingly light, well balanced and easy to handle.

Other equipment shown at the demonstration included the Berk Model 50 pistol, used as a pacemaker to the Model 61, the Berk 58 wire gun, and Berk grit-blasting units. A new development is the "Slim Jim" grit-blasting machine, which has been designed for lowering through small (18″) manholes where the internal surfaces of tanks are to be blasted.

Large Furnace Order

Recent news from **G.W.B. Furnaces Limited** is of a large order to build what they consider to be the largest and most powerful high frequency induction melting furnace in the United Kingdom. This order has been obtained from the North Eastern Iron Refining Company Limited and will be used for the production of highly specialized refined alloy pig irons and steel at their Stillington works. The first furnace body will have a capacity of up to 7 tons of molten metal, but the electrical equipment has been so designed that a second furnace body may have a capacity of just over 10 tons. The plant will be housed in the main cupola melting shop to allow for duplexing operations and machine casting.

The Stillington installation, for which the North Eastern Electricity Board is providing a new overhead supply, will comprise a 1,700 kW high frequency generating plant working in conjunction with a bank of water-cooled capacitors. A motorized 10,000 amp. furnace selector switch is also to be supplied to enable the high frequency power to be switched to either of two furnaces. The equipment will be engineered and built by G.W.B. to an approved design of Demag Elektrometallurgie. The unit is expected to be commissioned in December of this year.

News from Birmingham

Little change is noticeable in the industrial situation in the Midland area. Metal trades on the whole are well employed, and expansion in the engineering industries seems likely to continue. Yet another of the well-known factories in the motor trade has resumed its night shift working. There is a strong market for raw materials and components. Another very active industry is that of heavy electrical engineering, where some valuable overseas orders recently secured will ensure full employment for many months ahead. Steady business is being done in non-ferrous pressings and castings for the engineering trades.

A strong demand for all classes of steel for the building industry is a feature of the steel industry, and with rolling mills rolling a bigger range of products the gap between placing the order and obtaining delivery has been reduced. Greater activity in the motor trade has benefited sheet makers and the iron foundries. Supplies of semi-finished steel are readily available for the re-rolling trade, and although the iron foundries are using much more raw material than they were this time last year, there is no shortage. The major portion of the output of pig iron, however, relates to basic quality, which is readily taken up by steel producers.

World Tin Statistics

Mine production of tin-in-concentrates in the Federation of Malaya in April totalled 4,436 tons, against 4,512 in March, according to advance statistics published by the International Tin Council. Output in Thailand amounted to 1,162, against 1,069 in March, and in Bolivia to 1,633 tons in March, compared with 1,480 in February.

Exports of tin metal from Malaya and Singapore in May were 6,793, against 7,448 in April. U.K. exports of tin metal were 386 tons in April, against 635 in March.

Imports of tin-in-concentrates into Malaya and Singapore amounted to 1,644 tons in April, compared with 1,795 in March. U.K. imports in April were 1,055 tons against 2,471 in March. Only 319 tons of tin-in-concentrates were imported into the United States in March, compared with 1,188 tons in February. Imports of tin metal into the United States were 2,261 tons in March against 1,998 in February. Consumption of primary tin metal in the United States totalled 3,990 in March against 3,570 in February and 3,680 in January.

Southern Rhodesian Production

According to figures issued by the Department of Mines, Southern Rhodesia produced 982·34 tons of copper during April this year, compared with 951·36 tons in March and 261·60 tons in April 1960. Production during the first four months of the current year totalled 4,087·3 tons, against 3,368·78 tons during the corresponding period in 1960.

Southern Rhodesia produced 51,723 tons of chrome during April this year, compared with 54,864 tons in March, and 48,351 tons in April 1960. Total production for the first four months of the recent year amounted to 207,515 tons, compared with 204,813 tons in the corresponding period in 1960.

During April, Southern Rhodesia produced 7,992 fine ounces of silver compared with 7,255 ounces in March, and 6,847 ounces in April 1960. The accumulated total for the first four months of the current year was 50,599 ounces, compared with 96,080 ounces in the corresponding period a year ago.

Company Reports

Manganese Bronze and Brass Co.

Group net profit 1960, £329,025 (£344,128) and dividend 1s. 0½d. per 5s. share (same). Fixed assets £2,687,640 (£2,308,402). Net current assets £1,150,463 (£1,375,222), commitments £351,587.

Richard Johnson and Nephew

Group net profit, year to March 31, 1961, £851,698 (£1,087,688) and dividend 11 per cent (same). Total net assets of £8,980,371 (£8,508,003), include net current assets £5,184,352 (£5,108,813)—cash £59,049 (£36,627) against overdraft £501,406 (£169,312). Commitments £495,000 (£436,935).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Dunlop Metallurgical Services Limited (691616), Old Bank Buildings, High Street, Rotherham. Registered May 4, 1961. Nominal capital, £1,000 in £1 shares. Directors: Alan Criddle and Jack Phipps.

Heppenstall Metal Company Limited (691697), Robin Hood Yard, Attercliffe Road, Sheffield, 9. Registered May 4, 1961. Nominal capital, £100 in £1 shares. Directors: Walter Heselwood and Byron Heselwood.

Spencer Bros. (Chester) Limited (691738), Sheppard Works, Saltney, near Chester. Registered May 5, 1961. To carry on the business of dealers in ferrous and non-ferrous metals, etc. Nominal capital, £1,000 in £1 shares. Directors: Henry R. Spencer and Mrs. Rose Spencer.

H. W. Sharp and Sons (Wickford) Limited (691848), 19-20 Holborn Viaduct, E.C.1. Registered May 5, 1961. To carry on business of general merchants and dealers in non-ferrous scrap metals, etc. Nominal capital, £500 in £1 shares. Directors: Henry W. Sharp and Maurice H. Sharp.

Warnerson (Windscreens) Limited (692027), Vulcan Way, New Addington, Surrey. Registered May 8, 1961. To carry on business of manufacturers of metal frames for vehicle and ships' windows, workers in metals, etc. Nominal capital, £1,000 in £1 shares. Directors: Alan E. S. Warner and Donald V. Warner.

Conductors Limited (692044), 15a-17 Brecknock Road, N.7. Registered May 8, 1961. To carry on the business of manufacturers of and dealers in copper and other metals, generally of all kinds of electrical cables and wires, etc. Nominal capital, £100 in £1 shares. Directors not named.

Metalworks (High Wycombe) Limited (692163), Keep Hill Farm, Keep Hill Road, High Wycombe, Bucks. Registered May 9, 1961. Nominal capital, £100 in £1 shares. Directors: Ronald F. Emery, Maurice E. Emery and Jack H. Wilkinson.

B B. Electroplating Co. (Camberwell) Limited (692248), 118-120 Ormside Street, S.E.15. Registered May 10, 1961. Nominal capital, £6,000 in £1 shares. Directors: Walter F. Kirsch and Charles L. Garrod.

Guy Miller Limited (692331), 40 Park Square North, Leeds. Registered May 10, 1961. To carry on business of scrap metal merchants, etc. Nominal capital, £2,000 in £1 shares. Directors: John A. Miller and Jack Guy.

A.B.G. (Electrodepositors) Limited (692353), 2-4 Dingwall Avenue, Croydon. Registered May 11, 1961. Nominal capital, £1,000 in £1 shares. Director: John M. Benfield.

Bowmets Limited (692418), Bell Lane, London Colney, nr. St. Albans. Registered May 11, 1961. To carry on business of machinery and metal merchants, etc. Nominal capital, £1,000 in £1 shares. Directors: Herbert R. Gray, Cyril J. Wiseman and Peter W. Lane.

Metal Market News

RISING TENDENCY IN STOCKS — UNEASY WEEK FOR COPPER — LEAD EASIER MID-WEEK

ADVANCE details of copper and tin for the month of April were furnished last week by the British Bureau of Non-Ferrous Metal Statistics, which show rather a marked drop compared with the details for March. In copper, consumption of all grades in April was 53,976 tons, compared with 64,765 tons in the previous month. For the first four months of the year, the total was 233,842 tons, 11,721 tons down on the corresponding period in 1960. Stocks at April 30 were 126,949 tons, an advance of about 8,000 tons on March 31. In tin, consumption was 1,675 tons, compared with 2,093 tons in March, and stocks at 11,666 tons declined from the March figure of 12,398 tons. Even bearing in mind that the incidence of Easter in April reduced the number of working days by two, there were signs of a decline in activity. In both lead and zinc, a similar trend was discernible. In the case of lead, consumption of all grades in April amounted to 30,805 tons against 32,601 tons in March, while the zinc comparison was 27,271 tons, compared with 31,844 tons. The London Metal Exchange stocks, with the exception of tin, continue to show a rising tendency, and last week was no exception. The increase in copper was not large, no more than 60 tons, bringing the total up to 16,527 tons, but this must be deemed to be a satisfactory figure even though some people feel we could do with more.

As mentioned, the trend in tin is rather downwards and it may well be thought that this decline is due to selling by the Pool. Actually, there was a fall of 263 tons to 8,909 tons, and it will be noted that the Bureau figure mentioned above was well down at the end of April. Little change occurred in the L.M.E. lead tonnage, for the total of 11,618 tons registered a rise of only 19 tons. Zinc stocks have been rising for several months past and last week saw a substantial uplift of 694 tons to 7,911 tons. It was not very surprising in these circumstances to see a fairly sharp fall in the price. Actually, on a turnover of 10,350 tons prompt zinc dropped back by £2 2s. 6d. to £79 15s. 0d., while forward lost £2 5s. 0d. to £80 10s. 0d. It was, perhaps, a little surprising that the contango, instead of widening, came in by 2s. 6d. to 15s. Some 9,125 tons of lead changed hands, cash losing 22s. 6d. to £64 2s. 6d., while forward dropped 17s. 6d. to £65 7s. 6d.

Copper had a very uneasy week and fell as low as £236 10s. 0d. for cash and £239 for three months before recovering to close virtually unchanged at £240 10s. 0d. for cash and £243 three months. The turnover was 11,000 tons. When, in midweek, both positions fell below £240, there was a feeling that the decline had been rather overdone and this was confirmed by the buying which developed. In the States, the price of scrap declined by ¼ cent, but before that there had been a threat of an extension of the "white collar" strike at Braden to include other personnel. The week ended on a fairly firm note. Tin staged what must be nearly a record week's turnover of 2,440 tons, while both positions improved sharply in value, cash gaining £10 10s. 0d. to £880, and three months £14 to £889 10s. 0d. The contango widened to £9 10s. 0d.

New York

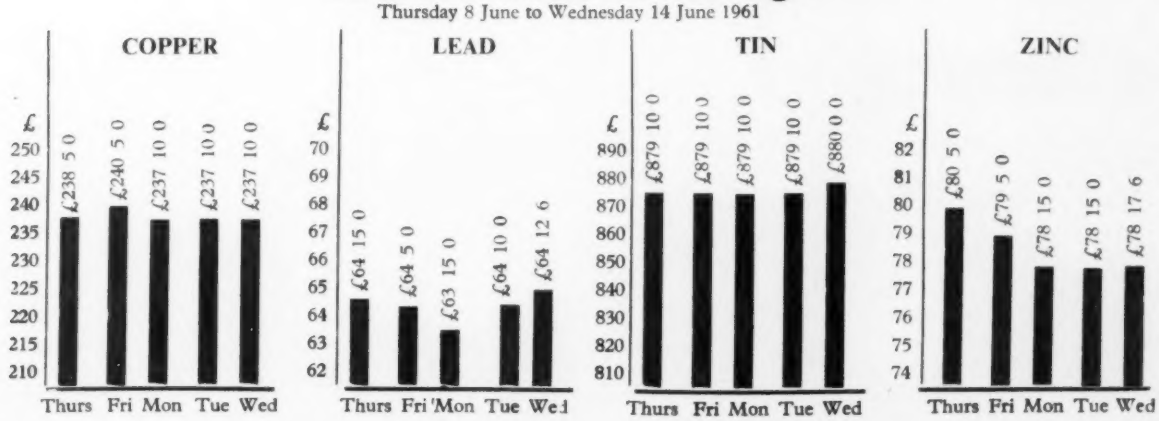
Copper futures were easier this week. Traders said the decline in London, the settlement of the El Teniente and Cerro strikes, and particularly the Mine Mill Union postponement of any possible strike action against Kennecott until late July or early August, induced the selling. Physical copper was barely steady in the export market. One usually reliable trade source said that dealer copper was sold to a consumer in fair tonnages below 31 cents, possibly at 30⅞ cents a lb. for prompt shipment. Other sources were sceptical but some traders indicated it could be true. Custom smelters noted quieter conditions, while producers reported continued satisfactory demand.

Leading sellers of zinc in New York, including custom smelters and producers say that currently the base price of zinc is stable at 11½ cents East St. Louis. They pointed out that demand from brass mills has been good, and the recent American Zinc Institute statistics were encouraging. These sources said that there were reports of discounts in the price of special high grade as much as ½ cent per lb. from the 12½ cents quoted price, but that prime western and high grade zinc prices were stable. Leading trade sources said that the recent Canadian price cut was mainly a move to bring Canadian zinc prices more in line with U.S. prices and that the Canadian zinc price was still higher than the U.S. quotation.

Informed sources in Washington have indicated that the General Services Administration and O.C.D.M. have agreed in principle on the release of 4,000 tons of Government-owned tin acquired from the Texas City smelter, but said the release must be approved by the State Department before any announcement is made officially. It is understood that the State Department has been in touch with the International Tin Council about an opportune timing for the release of the metal. A spokesman for the U.S. State Department said that no decision has yet been reached regarding the release of 4,000 tons of tin by the Government. He said that the matter was still under consultation with the other government agencies involved in the decision.

London Metal Exchange

Thursday 8 June to Wednesday 14 June 1961



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NON-FERROUS

PRIMARY METALS

All prices quoted are those available at 2 p.m. 14/6/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	237	10	0
Antimony Metal 99%	„	230	0	0
Antimony Oxide Commercial	„	194	10	0
Antimony White Oxide	„	212	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	0
Calcium	„	2	0	0
Cerium 99%	„	15	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite	per unit		8	10	0
Copper H.C. Electro	ton	237	10	0
Fire Refined 99·70%	„	236	0	0
Fire Refined 99·50%	„	235	0	0

		£	s.	d.
Copper Sulphate	ton	80	10	0
Germanium	grm.		—	
Gold	oz.	12	11	2
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	64	12	6
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		5	6
Alloy Ingot, AZ91X		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	67	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	7⅞
Tellurium Sticks	lb.	2	0	0
Tin	ton	880	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	79	6	3
Dust 95/97%	„	125	0	0
Dust 98/99%	„	131	0	0
Granulated 99+%	„	104	6	3
Granulated 99·99+%	„	118	16	3

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

All prices quoted are those available at 2 p.m. 14/6/61

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 ton	210	0	0
B.S. 1490 L.M.6 „	202	0	0
B.S. 1490 L.M.7 „	216	0	0
B.S. 1490 L.M.8 „	203	0	0
B.S. 1490 L.M.9 „	203	0	0
B.S. 1490 L.M.10 „	221	0	0
B.S. 1490 L.M.11 „	215	0	0
B.S. 1490 L.M.12 „	223	0	0
B.S. 1490 L.M.13 „	216	0	0
B.S. 1490 L.M.14 „	224	0	0
B.S. 1490 L.M.15 „	210	0	0
B.S. 1490 L.M.16 „	206	0	0
B.S. 1490 L.M.18 „	203	0	0
B.S. 1490 L.M.22 „	210	0	0
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 ton	160	0	0
B.S. 1490 L.M.2 „	161	0	0
B.S. 1490 L.M.4 „	170	0	0
B.S. 1490 L.M.6 „	176	0	0
***Aluminium Bronze**			
BSS 1400 AB.1 ton	252	0	0
BSS 1400 AB.2 „	260	0	0

		£	s.	d.
***Brass**				
BSS 1400-B3 65/35 ton	182	0	0
BSS 249 „		—	
BSS 1400-B6 85/15 „	229	0	0
***Gunmetal**			
R.C.H. 3/4% ton „		—	
(85/5/5/5) LG2 „	225	0	0
(86/7/5/2) LG3 „	234	0	0
(88/10/2/1) „	291	0	0
(88/10/2/½) „	301	0	0
***Manganese Bronze**			
BSS 1400 HTB1 „	197	0	0
BSS 1400 HTB2 „	216	0	0
BSS 1400 HTB3 „	236	0	0
Nickel Silver			
Casting Quality 12% „	260	0	0
„ „ 16% „	270	0	0
„ „ 18% „	310	0	0
***Phosphor Bronze**			
B.S.1400P.B.1.(A.I.D. released) „	317	0	0
B.S. 1400 L.P.B.1 „	249	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ton	266	10	0
15% „	269	10	0
Phosphor Tin			
5% „	955	0	0
Silicon Bronze			
BSS 1400-SB1 „	293	0	0
Solder, soft, BSS 219			
Grade C Tinmans „	398	10	0
Grade D Plumbers „	317	0	0
Grade M „	439	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
BSS 1004 Alloy A ton	112	6	3
BSS 1004 Alloy B „	116	6	3
Sodium-Zinc lb.		2	6½

SCRAP METALS

Merchants' average buying prices delivered, per ton, 13/6/61

Aluminium	£
New Cuttings	135
Old Rolled	104
Segregated Turnings	78
Brass	
Cuttings	168
Rod Ends	152
Heavy Yellow	143
Light	138
Rolled	157
Collected Scrap	141
Turnings	145

Copper	£
Wire	216
Firebox, cut up	214
Heavy	213
Light	209
Cuttings	221
Turnings	193
Braziery	185
Gunmetal	
Gear Wheels	207
Admiralty	207
Commercial	192
Turnings	187

Lead	£
Scrap	55
Nickel	
Cuttings	—
Anodes	554
Phosphor Bronze	
Scrap	192
Turnings	187
Zinc	
Remelted	74
Cuttings	67
Old Zinc	45

METAL PRICES

SEMI-FABRICATED PRODUCTS

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products

		£	s.	d.
Aluminium				
Sheet 10 S.W.G.	lb.		2	10½
Sheet 18 S.W.G.	,,		3	0½
Sheet 24 S.W.G.	,,		3	3½
Strip 10 S.W.G.	,,		2	10½
Strip 18 S.W.G.	,,		2	11½
Strip 24 S.W.G.	,,		3	1
Circles 22 S.W.G.	,,		3	4½
Circles 18 S.W.G.	,,		3	3½
Circles 12 S.W.G.	,,		3	2½
Plate as rolled	,,		2	10
Sections	,,		3	4
Wire 10 S.W.G.	,,		3	1½
Tubes 1 in. o.d. 16 S.W.G.	,,		4	4
Aluminium Alloys				
BS 1470. HS19W.				
Sheet 10 S.W.G.	,,		3	3
Sheet 18 S.W.G.	,,		3	5½
Sheet 24 S.W.G.	,,		4	1
Strip 10 S.W.G.	,,		3	3
Strip 18 S.W.G.	,,		3	4½
Strip 24 S.W.G.	,,		4	0½
BS1477. HP30M.				
Plate as rolled	,,		3	1
BS1470. HC15WP.				
Sheet 10 S.W.G.	,,		4	3
Sheet 18 S.W.G.	,,		4	8½
Sheet 24 S.W.G.	,,		5	8½
Strip 10 S.W.G.	,,		4	4
Strip 18 S.W.G.	,,		4	8½
Strip 24 S.W.G.	,,		5	4½

		£	s.	d.
Aluminium Alloys—cont.				
BS1477. HPC15WP.				
Plate heat treated	lb.		3	10½
BS1475. HG19W.				
Wire 10 S.W.G.	,,		4	2
BS1471. HT19WP.				
Tubes 1 in. o.d. 16 S.W.G.	,,		5	5
BS1476. HE19WP.				
Sections	,,		3	4
Split tube				
19 S.W.G. (⅛″)	,,		4	2
20 S.W.G. (⅜″)	,,		3	11
21 S.W.G. (⅜″)	,,		4	1
22 S.W.G. (¼″)	,,		4	11
Welded tube 14 to 20 S.W.G. (sizes ½″ to 1½″)	,,	3/10½ to 5/8½		
Brass				
Tubes	lb.		1	10⅝
Brazed Tubes	,,		3	3⅝
Drawn Strip Sections	,,		3	3⅝
Sheet	ton	206	5	0
Strip	,,	206	5	0
Extruded Bar	lb.		2	1
Condenser Plate (Yellow Metal)	ton	192	0	0
Condenser Plate (Naval Brass)	,,	205	0	0
Wire	lb.		2	9

		£	s.	d.
Beryllium Copper				
Strip	lb.	1	4	11
Rod	,,	1	1	6
Wire	,,	1	4	9
Copper				
Tubes	lb.		2	4½
Sheet	ton	272	0	0
Strip	,,	272	0	0
H.C. Wire	,,	291	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	7
Lead				
Pipes (London)	ton	107	0	0
Sheet (London)	,,	104	15	0
Tellurium Lead	,,	£6 extra		
Nickel Silver				
Sheet and Strip 10%	lb.		3	11¾
Wire 10%	,,		4	4¾
Phosphor Bronze				
Wire	,,		4	2¾
Titanium (1,000 lb. lots)				
Billet 4½″ to 18″ dia.	lb.	47/-		48/-
Rod ¼″ to 4″ dia.	,,	85/-		53/-
Wire ·036″-232″ dia.	,,	159/-		99/-
Strip ·001″ to ·048″	,,	350/-		68/-
Sheet 8′ × 2′. 20 gauge	,,	73/-		
Tube, representative average gauge	,,	198/-		
Extrusions	,,	90/-		
Zinc				
Sheet	ton	116	15	0
Strip	,,	nom.		

FOREIGN QUOTATIONS

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

Belgium	fr/kg	£/ton
Copper: electrolytic	33.75	246 13
Tin	122.00	891 13

Canada	c/lb	£/ton
Aluminium	26.00	210 12
Copper: electrolytic	30.00	243 0
Lead	10.00	81 0
Nickel	70.00	567 0
Zinc: Prime western	12.25	100 4
High grade 99.95	12.85	104 17
High grade 99.99	13.25	107 6

France	fr/kg	£/ton
Aluminium	2.43	179 11
Antimony 99·0	2.80	206 18
Cadmium	16.25	1,200 17
Copper: electrolytic	3.37	249 0
Lead	.97	71 13
Nickel	9.00	665 2
Tin	12.39	914 2
Zinc: Thermic	1.20	88 13
Zinc: electrolytic	1.28	94 11
Scrap		
Copper: electrolytic	2.97	219 9
Heavy copper	2.80	206 18
No. 1 copper wire	2.97	219 9
Brass rod ends	2.85	210 12
Zinc castings	.95	70 4
Lead	.90	66 10
Aluminium	1.70	125 12

Italy	lire/kg	£/ton
Aluminium	370	216 1
Antimony 99·0	520	303 13
Copper: wire bars 99.9	470	347 6
Lead	167	98 10
Nickel	1,180	689 2
Tin	1,620	956 1
Zinc: electrolytic	185	108 0
Scrap		
Aluminium soft sheet clippings (new)	305	178 2
Lead, soft, first quality	139	81 3
Lead, battery plates	79	46 2
Copper, first grade	395	230 13
Bronze, commercial gunmetal	350	204 8
Brass: heavy	285	166 8
Brass: light	270	157 12
Brass, bar turnings	285	166 8
Old zinc	108	63 0

Switzerland	fr/kg	£/ton
Aluminium	2.50	210 5
Copper: electrolytic	3.05	256 10
Lead	.85	71 9
Nickel	7.50	630 15
Tin	10.77	905 15
Zinc: High grade 99.99	1.10	92 10

Japan	Yen per metric ton
Scrap	
Copper: electrolytic	308,000
Copper wire No. 1	276,000
Copper wire No. 2	266,000
Heavy copper	273,000
Light copper	230,000
Brass, new cuttings	210,000
Red brass scrap	215,000

West Germany *Scrap*	D-marks per 100 kilos	£/ton
Used copper wire	235	214 1
Heavy copper	230	209 10
Light copper	205	186 15
Heavy brass	150	136 13
Light brass	120	109 6
Soft lead	58	52 16
Zinc	57	51 18
Used aluminium unsorted	90	81 19

United States	c/lb	£/ton
Aluminium	26.00	207 4
Antimony 99·0	32.50	259 0
Cadmium	160.00	1,275 4
Copper: electrolytic	31.00	247 10
Lead	11.00	87 13
Nickel	74.50	593 15
Tin	111.25	886 13
Zinc: electrolytic	25.50	98 12

THE STOCK EXCHANGE

Market Rather Dull With Support Rather Poor

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 12 JUNE +RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£			Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation	32/6	11	9	6 15 6	33/9	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3	NIL	4	NIL	1/3½	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries	41/6 —3d.	15	15	7 4 6	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	64/6 —3d.	10	15‡	3 2 0	78/9	45/-	51/3	29/-
4,795,000	1	Birmid Industries	92/3	20	20D	4 6 9	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	26/- —9d.	17½QT	12½	4 9 9	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6	5	5	6 18 0	14/6	13/9	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/-	6	6	7 1 3	17/6	16/9	20/-	17/1½
* 300,000	1	Bolton (Thos.) & Sons Pref. 5%	16/6	5	5	6 1 3	16/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6%	17/-	6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	62/- +3/3	13½	13½	4 7 3	62/-	49/-	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord.	21/3xcap —2/-	16D	16	2 13 0	28/4½	17/6	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	15/6 +6d.	15$\frac{3}{8}$	25 + *2½C‡	5 2 0	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/-	NIL	12½	—	1/7½	10½d.	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	30/4½	12	10	7 18 0	30/4½	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3	6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/- +3d.	15	15	7 10 0	4/5½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	72/- —1/-	20	15	5 11 0	81/6	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	163/9	30‡	20	1 16 9	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	25/- +9d.	20	17½	4 0 0	27/7½	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	43/- —2/-	15	15	6 19 6	52/3	43/-	56/9	45/-
1,155,000	1	Evered & Co.	45/6 +6d.	10B	10ϕ	2 19 0	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	33/9 —1/3	10	10	5 18 6	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd	62/- +1/6	25	20	4 0 6	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	19/-	15	13	3 19 0	21/1½	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	30/3	22½	25¶	3 14 6	30/3	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries	36/3 +6d.	15	19L	4 2 9	44/9	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	27/3xcap	30 ‡	30	5 10 0	29/6	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	14/3	*20‡	*17½	3 10 3	14/6	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/3	7	7	6 18 3	20/4½	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	14/6 —1/-	13	15	4 9 9	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries	73/- —2/6	13½	11½	3 15 3	81/6	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/6	5	5	6 9 0	16/-	14/10½	18/-	15/4½
29,196,118	**	International Nickel	140½ +2d.	$1.60	$1.50	2 0 0	152½	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/-	5	5	7 2 9	14/10½	13/6	16/6	14/6
6,000,000	1	Ditto Ord.	60/9 —1/6	12	12D	3 19 0	64/3	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	2'/-	17½	17½E	8 6 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	14/4½	12	10	3 6 9	15/-	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	67/-	17½F	15F	5 4 6	68/-	53/6	71/6	57/3
1,530,024	1	Ditto A. Ord.	66/6	17½F	15F	5 5 3	67/-	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	16/-	20$\frac{1}{2}$	20$\frac{1}{2}$	6 10 0	18/6	14/-	18/6	13/4½
50,628	6	Ditto (7½% N.C. Pref.)	5/9	7½	7½	7 16 0	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	86/6 —2/6	12	12M	2 15 6	100/9	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/-	50	50	12 10 0	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	52/6 +9/6	15	12½	5 14 3	51/6	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3	6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A	64/9	14	13	4 6 9	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref.	16/- +6d.	5½	5½	6 17 6	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	47/6 +1/-	22½J	15	4 15 0	52/-	39/9	45/-	35/3
585 000	5/-	Ratcliffs (Great Bridge) Ord.	16/- 3d.	10	10R	3 2 6	16/6	15/9	17/-	14/9
195 000	5/-	Ditto 8% Max. Ord.	4/10½	8	—	8 4 8	5/-	4/9	5/3	5/-
1,064,880	10/-	Sanderson Kayser	39/- —1/6	17½	35‡	4 12 0	41/3	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	18/7½	12½	17½GD	3 7 0	19/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	56/9 —2/6	16	15	5 12 9	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6	5½	5½	7 2 0	18/-	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	71/6 —2/6	14	20	3 18 3	85/6	70/6	140/3	63/10½
41,000,000	Stk (£1)	Vickers	35/- —2/3	10	10	5 14 3	38/3	28/-	39/7½	27/1½
750,000	Stk (£1)	Ditto Pref 5%	14/6 +6d.	5	5	6 18 0	15/-	12/7½	17/6	13/3
6,463,807	Stk (£1)	Ditto Pref. 5% tax free	20/6	*5	*5	7 5 0A	21/1½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	82/3 +9d.	13½	25	3 7 0	84/6	64/6	94/-	63/-
7,109 424	Stk (£1)	Westinghouse Brake	43/3	11	10	5 1 9	46/3	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting	9/6xd —7½d.	35	30	7 7 3	13/4½	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	28/-	32½	27½	5 16 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gall	4/7½	15	20‡	8 2 3	4/9	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/3	6	6	9 1 3	13/7½	13/3	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/1½	40	30	7 16 3	5/6	4/6	5/4½	4/-

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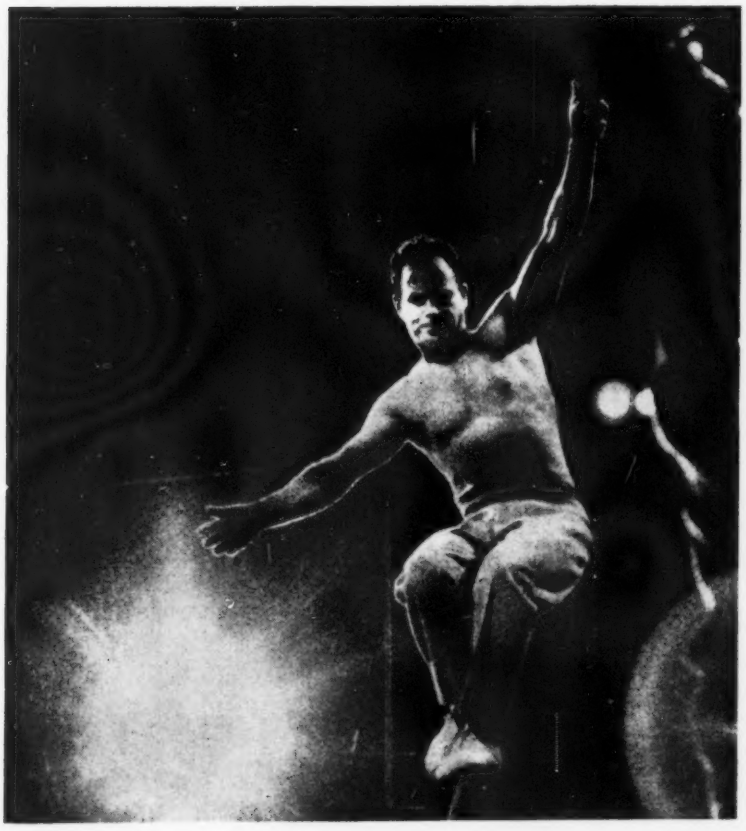

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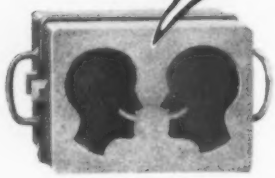

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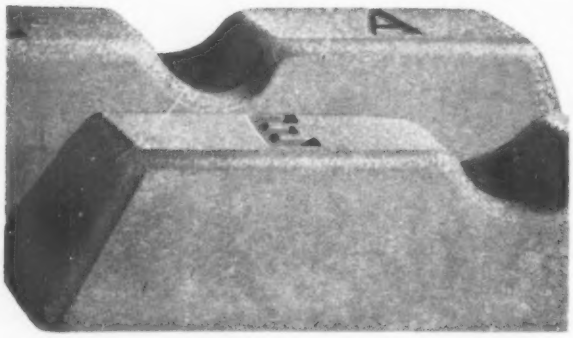

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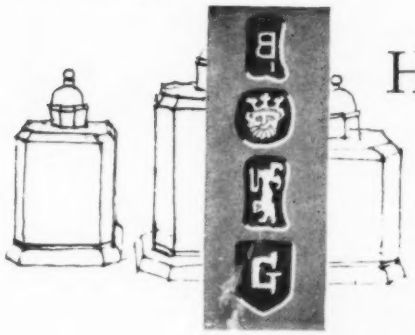

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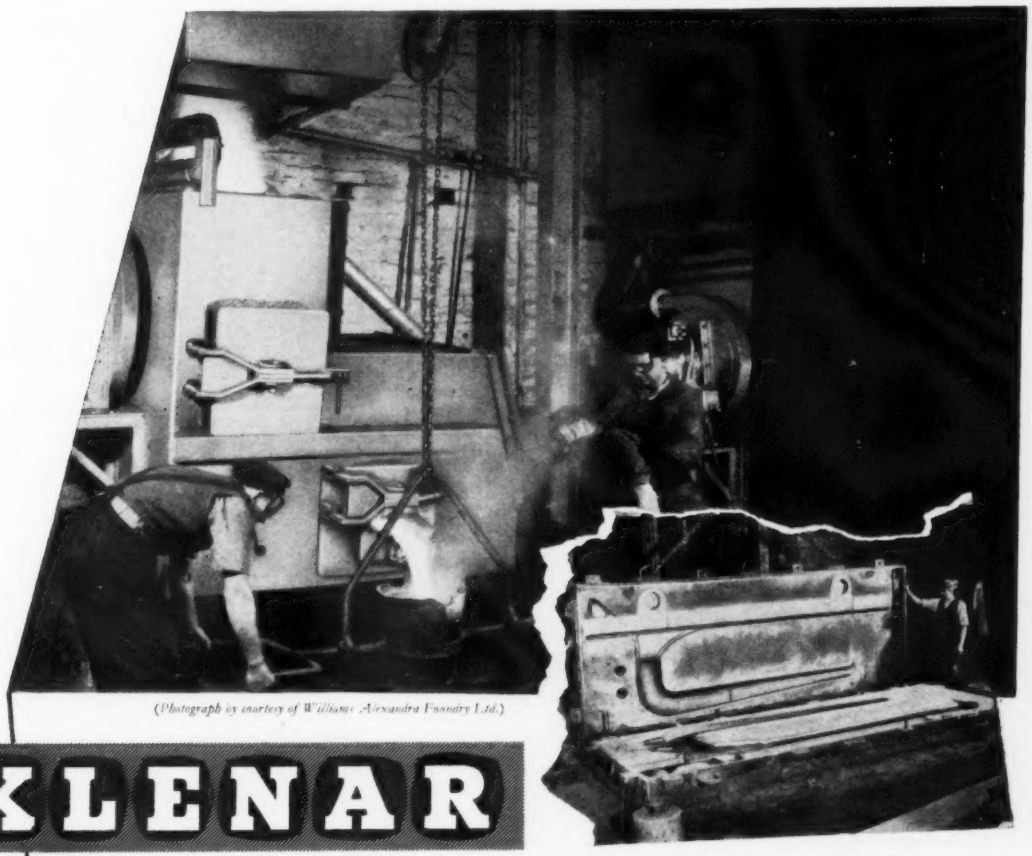

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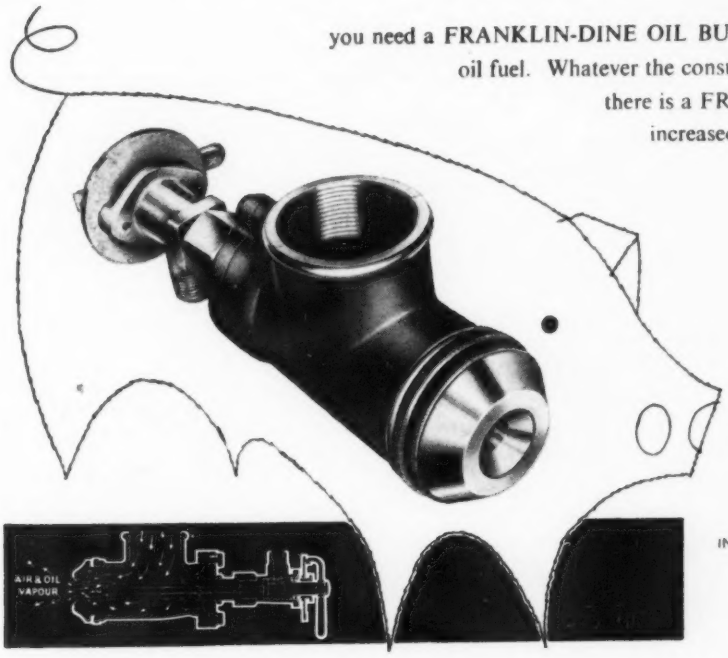

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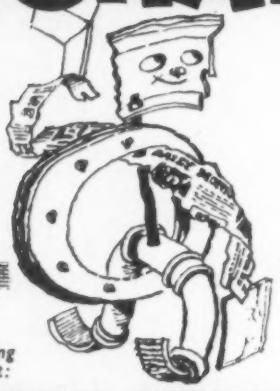

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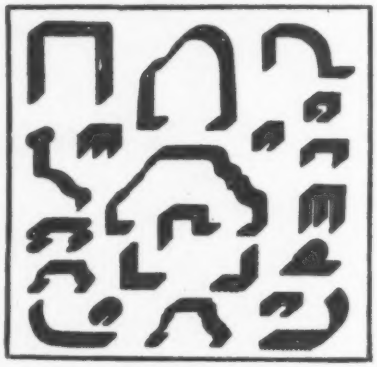

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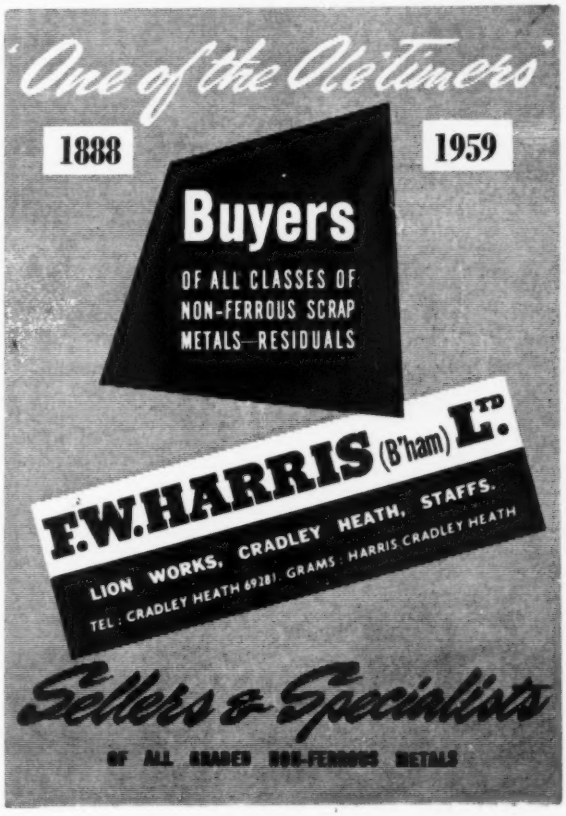

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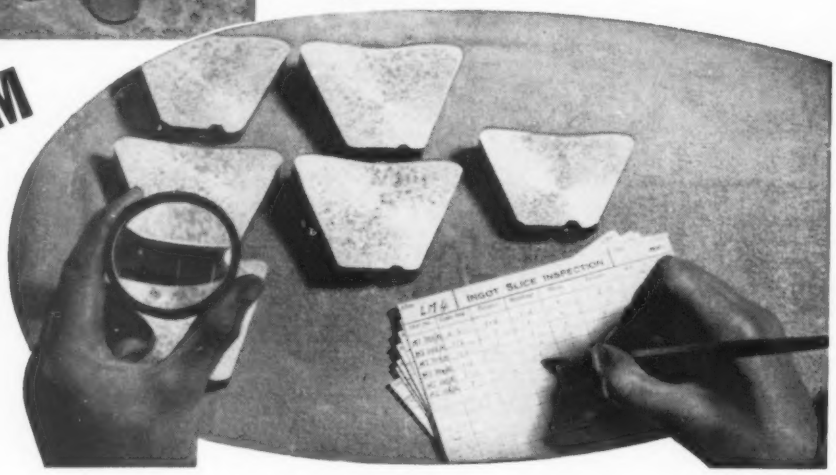

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